DOCUMENT RESUME

ED 401 441 CE 072 934

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|---|---|
| TITLE | Machine Tool Advanced Skills Technology (MAST). Common Ground: Toward a Standards-Based Training System for the U.S. Machine Tool and Metal Related Industries. Volume 11: Computer-Aided Manufacturing & Advanced CNC, of a 15-Volume Set of Skill Standards and Curriculum Training Materials for the Precision Manufacturing Industry. |
| INSTITUTION | Texas State Technical Coll., Waco. |
| SPONS AGENCY | Office of Vocational and Adult Education (ED), Washington, DC. |
| PUB DATE | Sep 96 |
| CONTRACT | V199J40008 |
| NOTE | 277p.; For other volumes in this set, see CE 072 924-938. |
| AVAILABLE FROM | World Wide Web: http://machinetool.tstc.edu |
| PUB TYPE | Guides - Classroom Use - Teaching Guides (For Teacher) (052) |
| EDRS PRICE | MF01/PC12 Plus Postage. |
| DESCRIPTORS | Automation; Behavioral Objectives; Competency Based Education; *Computer Assisted Manufacturing; Computer Software; Course Content; Course Descriptions; Curriculum; Curriculum Development; Job Skills; Machine Tool Operators; *Machine Tools; Manufacturing; Manufacturing Industry; *Metal Working; *Numerical Control; Postsecondary Education; *Technical Education |

ABSTRACT

This document is intended to help education and training institutions deliver the Machine Tool Advanced Skills Technology (MAST) curriculum to a variety of individuals and organizations. MAST consists of industry-specific skill standards and model curricula for 15 occupational specialty areas within the U.S. machine tool and metals-related industries. This volume provides the MAST standards and curriculum for the computer-aided manufacturing and advanced computer numerical control (CNC) specialty area. It is organized in the following sections: (1) a profile of San Diego City College, the development center that produced these standards and curriculum; (2) a computer-aided manufacturing and CNC technician competency profile of job duties and tasks; (3) a technician duty, task, and subtask outline; (4) a course curriculum outline and course descriptions; (5) a technical workplace competencies and course crosswalk; and (6) a Secretary's Commission on Achieving Necessary Skills (SCANS) proficiencies course crosswalk. Individual syllabi for the following courses are provided: Basic Principles of Machine Technology; Introduction to CNC and Electro-Discharge Machining (EDM); Introduction to CNC Verification and Communication; Introduction to Computer Aided Design/Manufacturing (CAD/CAM); Applications of CAD/CAM I; Introduction to CNC Controlled Vertical Machining and EDM; Application of CNC Controlled Vertical Machining and EDM; Advanced CAD/CAM; Application in Advanced CAD/CAM I; Introduction to CNC Controlled Turning; and Applications of CNC Controlled Turning. Components of each syllabus are as follows: lecture, lab, and credit hours; course description; prerequisites; course objectives; required course materials; method of instruction; course objectives: technical competencies; and course objectives: SCANS competencies. Appendixes contain the individual competency profiles for each company surveyed by the MAST development center. and narrative of the pilot program for this occupational specialty. (YLB)

ED 401 441

# Machine Tool Advanced Skills Technology

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## COMMON GROUND: TOWARD A STANDARDS-BASED TRAINING SYSTEM FOR THE U.S. MACHINE TOOL AND METAL RELATED INDUSTRIES

## VOLUME 11

## COMPUTER-AIDED MANUFACTURING & ADVANCED CNC

of
a 15 volume set of Skills Standards
and
Curriculum Training Materials for the
PRECISION MANUFACTURING INDUSTRY

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***Machine Tool Advanced Skills Technology Program***

# MAST

## VOLUME 11

## COMPUTER-AIDED MANUFACTURING & ADVANCED CNC

Supported by
The Office of Vocational and Adult Education
U.S. Department of Education

September, 1996

# GRANT INFORMATION

| | |
|---|---|
| Project Title: | Machine Tool Advanced Skills Technology Program |
| Grant Number: | V199J40008 |
| Act under which Funds Administered: | Carl D. Perkins Vocational Education Act<br>Cooperative Demo - Manufacturing Technology, CFDA84.199J |
| Source of Grant: | Office of Vocational and Adult Education<br>U.S. Department of Education<br>Washington, DC 20202 |
| Grantee: | Texas State Technical College<br>Waco, Texas |
| Disclaimer: | This publication was prepared pursuant to a grant with the Office of Vocational and Adult Education, U.S. Department of Education. Grantees undertaking such projects under government sponsorship are encouraged to express freely their judgement in professional and technical matters. Points of view or opinions do not, therefore, necessarily represent official U.S. Department of Education position or policy. |
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# ACKNOWLEDGMENTS

This project was made possible by the cooperation and direct support of the following organizations:

- U.S. Department of Education, Office of Vocational & Adult Education
- MAST Consortia of Employers and Educators

**MAST DEVELOPMENT CENTERS**

Augusta Technical Institute - Itawamba Community College - Moraine Valley Community College - San Diego City College (CACT) - Springfield Technical Community College - Texas State Technical College

**INDUSTRIES**

AB Lasers - AIRCAP/MTD - ALCOA - American Saw - AMOCO Performance Products - Automatic Switch Company - Bell Helicopter - Bowen Tool - Brunner - Chrysler Corp. - Chrysler Technologies - Conveyor Plus - Darr Caterpillar - Davis Technologies - Delta International - Devon - D. J. Plastics - Eaton Leonard - EBTEC - Electro-Motive - Emergency One - Eureka - Foster Mold - GeoDiamond/Smith International - Greenfield Industries - Hunter Douglas - Industrial Laser - ITT Engineered Valve - Kaiser Aluminum - Krueger International. - Laser Fare - Laser Services - Lockheed Martin - McDonnell Douglas - Mercury Tool - NASSCO - NutraSweet - Rapistan DEMAG - Reed Tool - ROHR, International - Searle - Solar Turbine - Southwest Fabricators - Smith & Wesson - Standard Refrigeration - Super Sagless - Taylor Guitars - Tecumseh - Teledyne Ryan - Thermal Ceramics - Thomas Lighting - FMC, United Defense - United Technologies Hamilton Standard

**COLLEGE AFFILIATES**

Aiken Technical College - Bevil Center for Advanced Manufacturing Technology - Central Florida Community College - Chicago Manufacturing Technology Extension Center - Great Lakes Manufacturing Technology Center - Indiana Vocational Technical College - Milwaukee Area Technical College - Okaloosa-Walton Community College - Piedmont Technical College - Pueblo Community College - Salt Lake Community College - Spokane Community College - Texas State Technical Colleges at Harlington, Marshall, Sweetwater

**FEDERAL LABS**

Jet Propulsion Lab - Lawrence Livermore National Laboratory - L.B.J. Space Center (NASA) - Los Alamos Laboratory - Oak Ridge National Laboratory - Sandia National Laboratory - Several National Institute of Standards and Technology Centers (NIST) - Tank Automotive Research and Development Center (TARDEC) - Wright Laboratories

**SECONDARY SCHOOLS**

Aiken Career Center - Chicopee Comprehensive High School - Community High School (Moraine, IL) - Connally ISD - Consolidated High School - Evans High - Greenwood Vocational School - Hoover Sr. High - Killeen ISD - LaVega ISD - Lincoln Sr. High - Marlin ISD - Midway ISD - Moraine Area Career Center - Morse Sr. High - Point Lamar Sr. High - Pontotoc Ridge Area Vocational Center - Putnam Vocational High School - San Diego Sr. High - Tupelo-Lee Vocational Center - Waco ISD - Westfield Vocational High School

**ASSOCIATIONS**

American Vocational Association (AVA) - Center for Occupational Research and Development (CORD) - CIM in Higher Education (CIMHE) - Heart of Texas Tech-Prep - Midwest (Michigan) Manufacturing Technology Center (MMTC) - National Coalition For Advanced Manufacturing (NACFAM) - National Coalition of Advanced Technology Centers (NCATC) - National Skills Standards Pilot Programs - National Tooling and Machining Association (NTMA) - New York Manufacturing Extension Partnership (NYMEP) - Precision Metalforming Association (PMA) - Society of Manufacturing Engineers (SME) - Southeast Manufacturing Technology Center (SMTC)

**MAST PROJECT EVALUATORS**

Dr. James Hales, East Tennessee State University and William Ruxton, National Tooling and Machine Association (NTMA)

**SPECIAL RECOGNITION**

Dr. Hugh Rogers recognized the need for this project, developed the baseline concepts and methodology, and pulled together industrial and academic partners from across the nation into a solid consortium. Special thanks and singular congratulations go to Dr. Rogers for his extraordinary efforts in this endeavor.

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This report is primarily based upon information provided by the above companies, schools and labs. We sincerely thank key personnel within these organizations for their commitment and dedication to this project. Including the national survey, more than 3,000 other companies and organizations participated in this project. We commend their efforts in our combined attempt to reach some common ground in precision manufacturing skills standards and curriculum development.

This material may be found on the Internet at **http://machinetool.tstc.edu**

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# VOLUME 11
# COMPUTER-AIDED MANUFACTURING AND ADVANCED CNC TECHNOLOGY

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# FOREWORD

American manufacturers are struggling to adjust to the impact of global competition, shrinking product life cycles, and changing consumer demand. Both factories and workers are under pressure to keep pace with more exacting requirements in the form of near zero inventories, submicron tolerances, and defect rates in the parts per billion. As companies streamline their operations to remain competitive, they often use CNC equipment to help accomplish these goals. This transition to CNC has reduced blue-collar and mid-level management jobs and placed more responsibility on technical employees. The result is a surplus of workers whose jobs are now obsolete, and growing demand for a new type of worker whose skills and knowledge straddle once distinct technical areas. Manufacturing productivity, defined as net output per worker hour, depends increasingly on the ability of these workers to use new technologies, including computer-assisted design (CAD), computer-assisted manufacturing (CAM), and computer numerical control (CNC), to achieve product and process improvements prior to actual production.

Unfortunately, there is evidence that the manufacturing sector faces a critical shortage of workers with the skills to use these new technologies effectively. Important changes in machine tool technology, especially the migration to the use of CNC to automate processes that were previously craft-based has forever altered the operational paradigms of machine tool and metal-related manufacturers. The flexibility and reliability of modern CNC machine technology allows a company to operate efficiently with only a handful of machines and a reduced workforce, yet produce a larger number of product variations at high quality and low cost. The new capability is driving demand for multi-skilled technicians who can work comfortably with CAD-based engineering data and CAM-based manufacturing data, select and operate the appropriate CNC tool for machining, and use solid-modeling software to verify a cut before it is made. This describes a set of general duties once distributed among a machinist, NC operator, and computer programmer.

**Recognizing the need to increase the supply of new skilled workers in this and other occupations for the metal and metals-related industries, the U.S. Department of Education launched the Cooperative Demonstration Program (Manufacturing Technologies) as part of the National Skills Standards Act of 1994. The goal of the Department initiative was to foster the development and implementation of national skill standards and a training model for certificate and Associate of Science degree programs. In July 1994, a multi-state consortium of community colleges led by Texas State Technical College received a grant awarded by the Department under the initiative. The Machine Tool Advanced Skills Technology (MAST) consortium, which includes six of the nation's leading Advanced Technology Centers (ATCs), was formed to develop, test and disseminate industry-specific skill standards and model curricula for the U.S. machine tool industry over a two year period. As part of the MAST consortium, San Diego City College in California was tasked with developing and piloting skill standards and model curricula in the technical area of CNC/CAM Technician.**

The present report examines the results of the San Diego project in developing the CNC/CAM Technician standards and curriculum. The design of an effective system of national skill standards

and training for CNC/CAM Technician and other technical occupations must look to the future as well. (Following are several key developments that have guided the MAST program.)

1. Clear trends in manufacturing technology are toward increasing standardization, away from large plant investment, and toward highly varied small batch production concentrated in a single manufacturing cell. As a result, more companies will look to hire generalists with specific expertise in CAM and CNC technologies. Learning CNC turning is relatively simple for a technician with experience in CNC milling, and requires little in the way of training from his/her employer.

2. Producing the new CNC/CAM Technician identified through MAST is in the mutual interests of both schools and industry. The nation's smaller manufacturers need to be assured of an available supply of trained, fundamentally sound technicians, access to cutting-edge applied research facilities, and the educational expertise needed to retrain their employees as needed. Schools will continue to require money, equipment, research ideas, jobs for their graduates, and the reputation for relevance and industry access required to attract faculty and students. These mutual interests are natural ties that will be strengthened through agreement on performance-based standards.

3. U.S. Manufacturing is becoming more science-based, and its processes more precise and repeatable, at the same time that the lack of clear and accepted standards for knowledge and skills in the manufacturing sciences threatens to undermine the competitiveness of its future workforce. The possible salvation in regard to this last trend is that the steady advance of CNC automation is absorbing more and more of the need for such knowledge.)

After numerous interviews with practitioners from industry (see Appendix A), and discussions with educators, managers, supervisors, and others involved with machine related occupations, the MAST Consortia Partners have agreed to present our definition of a CNC/CAM Technician as follows:

**CNC/CAM TECHNICIAN:** *Program, edit, set-up, and operate CNC lathes, mills, and grinders to perform machining operations necessary to produce work pieces to referenced engineering standards. Use knowledge and skills to convert CAD-based engineering designs into appropriate CAM-based manufacturing applications.*

The CNC/CAM Technician training program, begun by San Diego City College in 1992 and developed further as a result of MAST, seeks to meet present employer needs and anticipate future demand by supplying industry with technicians schooled in the latest advances in CAD/CAM technology. The CAD/CAM training program also serves to provide its students with a good foundation in the area of CAD since these technologies are so closely related and intertwined. The foundation for all graphic simulation programs is CAD and students involved with the programming and operation of CNC equipment must possess good CAD foundation skills along with CNC skills. This program is described in the chapters that follow.

# PARTNER OCCUPATIONAL SPECIALITY ASSIGNMENTS

Although each of the six partner college development centers possessed detailed expertise in each of the MAST 15 occupational specialities, a division of work was still very necessary to ensure completion of the project due to the enormity associated with industrial assessment and complete curriculum revision for each of the areas of investigation.

Each Collegiate Partner was responsible for development of a specialization component of the overall model. Information for the future direction of this specialization area was obtained from NIST Manufacturing Centers and/or national consortia, professional societies, and industrial support groups addressing national manufacturing needs. Each Collegiate Partner tested its specialization model utilizing local campus resources and local industry. Information gained from the local experience was utilized to make model corrections. After testing and modification, components were consolidated into a national model. These events occurred during the first year of the Program. During the second year of the Program, the national model was piloted at each of the Collegiate Partner institutions. Experience gained from the individual pilot programs was consolidated into the final national model.

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What follows is a profile of the MAST development center which had primary responsibility for the compilation and preparation of the materials for this occupational specialty area. This college also had the responsibility for conducting the pilot program which was used as one of the means of validation for this program.

**MAST DEVELOPMENT CENTER, SAN DIEGO, CA**
**Center for Applied Competitive Technologies**
**San Diego City College**

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**Manufacturing in the San Diego Region**

Manufacturing represents a major sector of the San Diego economy, accounting for almost one out of every four dollars (24%) of San Diego's gross regional product. The county is currently home to approximately 3,500 manufacturers employing roughly 110,000 San Diegans. During the first half of the 1990s, manufacturing in San Diego was hard hit by the downturn in military and defense spending which accompanied the end of the cold war. Many of the region's largest aerospace contractors rapidly downsized or moved their plants out of state, leaving a large supplier base that needed to modernize its manufacturing processes and convert to commercial markets. Rapid recovery of manufacturing in the region has been driven by San Diego's high tech research and development sectors in electronics, telecommunications, software, advanced materials, biotechnology, and medical instrumentation.

**San Diego City College and its Center for Applied Competitive Technologies (CACT)**

San Diego City College is an urban, minority institution, serving a large population of students from immigrant, disadvantaged, and low income households. In 1990, the College saw an opportunity to modernize its technical programs and improve the employment outlook for many of its students by agreeing to host one of the State of California's eight new regional manufacturing extension centers, the Centers for Applied Competitive Technologies (CACTs). The advanced technology centers were designed to assist local companies to modernize their manufacturing processes and convert from defense to newly emerging, technology-based commercial markets. This strategic partnership between the College and its resident CACT has proven to be highly successful. In developing the programs and lab facilities to serve the needs of regional manufacturing companies, the San Diego CACT and City College have simultaneously modernized the manufacturing and machine technology credit offerings of the College, thereby providing a well-trained, technically competent workforce for industry and enhancing career opportunities for students.

**Development Team**

- **Project Director:** Joan A. Stepsis, Ph.D., Dean/Director of the CACT-SD, served as programmatic manager and academic coordinator for the MAST project.
- **Subject Matter Expert:** John C. Bollinger, Assoc. Prof. of Machine Technology, had programmatic responsibility for developing skill standards and course/program materials for the Advanced CNC and CAM component of the MAST project. Professor Bollinger also served as the lead instructor for the MAST instructional pilot for his specialty area.
- **Subject Matter Expert:** Douglas R. Welch, Assoc. Prof. of Manufacturing, had programmatic responsibility for developing skill standards and course/program materials for the Automated Equipment Technology (AET) and Machine Tool Integration (CIM) component of the MAST project. Professor Welch also served as lead instructor for the MAST instructional pilot for his specialty area.
- **Skills Validation Coordinator:** Mary K. Benard, MBA, CACT-SD Business/Operations Manager, coordinated the industry skills verification process for MAST with the assistance of Louis A. Spain, Jr., of Spain & Associates, who facilitated industry skills validation sessions with expert worker teams.

# THE MAST COMPETENCY PROFILE

Development of Competency Profiles at each of the MAST sites began with visits to representative companies for the purpose of surveying expert workers within the industry and occupational areas under investigation. Each site began the survey process by asking a subject matter expert in the targeted technical area, generally a member of their faculty, to employ a modified version of the generally-accepted DACUM (Developing A Curriculum) method to categorize the major skills needed to work in the selected occupation. As source materials, the college instructors drew on their professional knowledge and experience of current and future industry requirements. The initial skill standards developed by the subject matter experts underwent numerous internal reviews and revisions within each site, assuming final form as a series of structured survey and interview statements designed to elicit a simple yes or no response.

To determine an appropriate survey sample, each site compiled a database of their region's small and medium-sized manufacturers and searched for companies likely to employ workers in the targeted occupational area. The resulting cross-industry samples were sorted further to achieve a balance of technological capability and workforce size; the sample companies within each region were then asked to participate in the project. Willing respondents were scheduled for interviews.

During the company interviews, MAST staff asked expert workers to identify the primary duties and tasks performed by a typical worker and to consider the special skills and knowledge, traits and attitudes, and industry trends that will have an impact on worker training, employability, and performance both now and in the future. The interview results were analyzed to create individual profiles identifying the most common duties and skills required of workers at each company. Copies of individual company competency profiles are provided in Appendix A of this volume. These individual company Competency Profiles served two purposes. First, they showed, in a format that could be easily understood by both industry and educators, a picture of the occupational specialty at a given company at that particular time. Second, these individual company Competency Profiles furnished the company with a document for which they could claim ownership. This, in effect, made them "real" partners in the work of MAST.

Data for all companies were then aggregated to develop a composite Competency Profile of industry skill standards within the selected occupational specialty area of, as shown in the following pages.

These same duties and tasks were then included in both the Texas and National Surveys for further validation (see Volume 1). As a result of the surveys, additional refinements were made to the Competency Profiles. These changes were then incorporated into the individual course syllabi which were used for the pilot program.

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The MAST Competency Profile for this occupational specialty area has been included on the following pages.

## OCCUPATIONAL SURVEY AND COMPETENCY PROFILE

**San Diego City College/Center for Applied Competitive Technologies**

San Diego City College is a predominantly minority institution in a city where defense cutbacks and economic recession have shuttered scores of plants and businesses and eliminated tens of thousands of jobs. To continue to meet the needs of its students and ensure their present and future employability, City College has worked closely with industry to design comprehensive Associate of Applied Sciences (AAS) Degree programs in science, math, engineering and technology, as well as certificate programs in advanced machine tool and manufacturing technologies. These partnerships have helped to leverage public funds and led to the creation of a state-of-the-art applied research facility on the College campus. Key to this effort has been the role of the Center for Applied Competitive Technologies at San Diego City College (CACT-SDCC).

CACT-SDCC was established in 1990 as one of eight advanced technology centers (ATCs) funded by the State of California to help manufacturers modernize their production capabilities and remain competitive through education, training and technology transfer. Now six years old and a leading institution for applied research, education and training in automated manufacturing and machine technology, CACT-SDCC serves over 3,500 small- and mid-sized manufacturers in San Diego and Imperial Counties. The Center is a member of the National Coalition of Advanced Technology Centers (NCATC), an affiliate of the NIST California Manufacturing Technology Center (CMTC), based at El Camino College in Los Angeles, and the sole provider of the State's California Aerospace Supplier Improvement Program (CalSIP) for the San Diego region.

The roles of San Diego City College and CACT-SDCC in the MAST project mirror their reasons for selection to the consortium assembled by Texas State Technical College. City College provides the infrastructure of faculty, students, research facilities, and beta site for the model curriculum, while CACT-SDCC lends its knowledge and expertise as CMTC affiliate and NCATC member and its ongoing relationships with manufacturers.

**CAM/CNC Technician: Survey Methodology**

The CAM/CNC Technician survey methodology was designed to build on the strength of CACT-SDCC's existing relationship to the region's industrial base, as it was assumed that the Center's industry experience and knowledge would ensure the relevance and credibility of the skills survey and eventual curriculum. Given the compressed time frame for conducting the MAST industry survey, CACT-SDCC asked a member of the College faculty, a subject matter expert in CAM/CNC technologies, to employ a modified version of the generally-accepted DACUM (**D**eveloping **A** **C**urriculum) process to identify the major types of skills required for employment in the selected occupation. As source materials, the subject matter expert drew on his own training and experience as a journeyman machinist, his professional knowledge of current and future requirements as an active consultant to industry, and the current College instructional curriculum.

The initial set of skill standards developed by the subject matter expert underwent numerous internal reviews and revisions by a team of CACT-SDCC staff, working with a manufacturing

consultant with twenty years of industry experience. Upon assuming its final form as a series of structured statements designed to elicit a simple yes or no response, the resulting survey was sent to an industry sample for review.

To determine an appropriate sample survey population, CACT-SDCC searched its database of the region's small and medium-sized manufacturers for companies likely to employ CAM/CNC technicians. The resulting database of companies included both smaller tool and die shops with minimal technology and large aerospace manufacturers with a substantial investment in advanced technology; this sample was sorted further to achieve a balance of technological capability and workforce size.

Eight companies ultimately agreed to participate in the entire survey process; about half were current or previous CACT-SDCC clients, ranging in size from as few as three to over 5,000 employees. The companies included: Davis Technologies, a small machine shop; Southwest Fabricators, another job shop; Eaton Leonard, a subsidiary of a large manufacturer; NASSCO, a large shipbuilder; Rohr, a large aerospace manufacturer; Teledyne Ryan Aeronautical, a large aerospace manufacturer; Solar Turbines, a large aerospace firm and subsidiary of Caterpillar; and Taylor Guitar, a maker of musical instruments.

The CACT-SDCC Site Coordinator and the manufacturing consultant sent the full survey to all eight companies and followed up with a one and a half hour structured interview at each site, generally with the director of manufacturing or CEO. Survey results were entered into the CACT-SDCC computer database and aggregated into individualized Competency Profiles for the surveyed companies. The Competency Profile is a matrix consisting of nine rows of Duties (e.g., "Program CNC machines and EDM") and up to thirteen columns of Tasks (e.g., "Describe and interpret CNC coding systems"). The individual Profiles were sent back to each of the companies for final review and verification; the final Competency Profiles for the eight companies are discussed below and provided in Appendix A.

**Competency Profile Results**

Identification of tasks did not vary greatly across companies with the exception of Southwest Fabricators, which required far fewer tasks to fulfill the duties of "apply mathematical concepts" and "use computers". The company did not expect applicants to use Windows, Windows NT, or EDM; to interpret reference tables and apply the Cartesian coordinate system in machining; to compute feed rates or RPMs; or to perform depth of cut, thread cutting, or tap drill calculations.

Among "Current Trends/Concerns", Southwest Fabricators highlighted Statistical Process Control, Laser Machining, Advanced Computer Applications, Robotics, Environmental Concerns, DNC, Automated Material Handling Equipment, and CIM; to the same concerns, Solar Turbines added Fiber Optic Controls, JIT, ISO 9000, Feature-Based Design (Standardization), Standardized Parts, and MRP. Companies did not differ significantly in their lists of required "Tools and Equipment".

In general, most of the manufacturers stated in interviews that they were looking for entry-level technicians with a solid base of technical knowledge, some programming experience, and the

hands-on skill and ability to optimize machine tool flexibility and performance and minimize set-up and down time. The ideal candidate would have the theoretical and practical foundation to identify and program the conditions for optimal machine set-up and performance, coupled with the systems perspective required to determine when there is deviation and call in the repair man or equipment supplier for maintenance or process improvement.

Industry responses to open-ended questions tended to emphasize their particular areas of interest and generated valuable data that were incorporated into the draft curriculum outline. Taylor Guitar, for example, looks for workers with basic math and science knowledge and the technical skills and perspective of the traditional craftsperson, and downplays the importance of advanced technological expertise. Because its product -- i.e., high-end acoustic guitars -- employs relatively fixed and non-standard technology, Taylor cannot afford to rely on equipment suppliers for process improvement and looks instead to workers to add value in that area. Many of the machine tools in the Taylor factory have been custom-built by employees and the requisite skills and knowledge are prized by management. The founder Bob Taylor stated simply, "Give me people who know how to make things. We'll teach them the rest."

It is clear that the College's new CAM/CNC Technician program has the potential to help generate regional demand for its own product, as companies learn more about the program and begin to modify their production capability to incorporate the available sources of labor market expertise and technology. The survey also appeared to cause the companies to examine their own technology needs and practices and to think systematically about the set of skills they would like to see in new employees.

**Occupational Requirements for CAM/CNC Technician**

In general, the review of the MAST skill standards by local manufacturers confirmed the basic knowledge and skill sets identified as occupational requirements for CAM/CNC Technician by the subject matter experts. According to the companies surveyed, an increasing number of commercial product markets require the machining of smaller, complex components. This shift by industry is fueling demand for multi-skilled technicians, especially among small- and mid-sized manufacturers (average size 12-15 employees) who cannot afford to hire an engineer. With the growing industry adoption of CAM and CNC machine tools, these technicians are expected to have many of the basic skills and abilities of a machinist combined with knowledge of computers, computer programming, and electronics -- areas that fall outside the traditional occupational requirements for a machinist.

The role of a machinist, whether manual or computer-controlled, is to make or repair tools, machines and parts. The job requires the ability to read and understand blueprints and part specifications, calculate dimensions and tolerances, and use different machines (e.g., lathes, mills, drills, borers, cutters, grinders, finishers) and materials (e.g., metals, plastics, ceramics, composites) for specific applications. The dozens of specialized workplace classifications for machinist (e.g., aircraft or automotive machinist, cam maker, gear finisher/shaper, jig borer, lathe operator, pattern maker, radial drill-press operator) attest to the variety of skills and needs that can appear throughout industry.

The role of a CNC machinist, according to the Dictionary of Occupational Titles (Code 609.362-010), is to program, edit, set up, and operate CNC lathes, mills, and grinders, in order to machine work pieces to referenced engineering standards. In addition to the basic abilities required of the machinist, the requirements presume the knowledge and skills needed to understand and apply CAD-based engineering specifications to various CAM-based manufacturing applications, and to program and operate CNC and electronic discharge machines (EDM).

**SCANS**

The MAST skill standards development process incorporated a modified version of the five work-related competencies and three foundation skills identified by the Secretary's Commission on Achieving Necessary Skills (SCANS) as being essential to every job. Industry survey respondents were asked to review two SCANS skill sets -- i.e., Skills and Knowledge, and Traits and Attitudes -- in the context of the proposed occupational skill standards. The industry-verified SCANS skills will be incorporated into the CAM/CNC instructional curricula through selected courses.

**SKILLS AND KNOWLEDGE**

Communication Skills
Use Measurement Tools
Use Inspection Devices
Mathematical Skills
Reading/Writing Skills
Knowledge of Safety Regulations
Practice Safety in the Workplace
Organizational Skills
Knowledge of Company Policies/Procedures
Mechanical Aptitude
Ability to Comprehend Written/Verbal Instructions
Basic Knowledge of Fasteners
Ability to Work as Part of a Team
Converse in the Technical Language of the Trade
Knowledge of Occupational Opportunities
Knowledge of Employee/Employer Responsibilities
Knowledge of Company Quality Assurance Activities
Practice Quality-Consciousness in Performance of the Job


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**TRAITS AND ATTITUDES**

Strong Work Ethic
Interpersonal Skills
Punctuality
Dependability
Honesty
Neatness
Safety Conscientious
Motivation
Responsible
Physical Ability
Professional
Trustworthy
Customer Relations
Personal Ethics

**TOOLS AND EQUIPMENT**

Machinist's Tools (e.g., calipers, dial indicators magnetic tool holders, etc.)
Measuring Tools
Power Tools
Metal Lathe with Attachments
Drill Presses
Vertical Mill with Attachments
Power Saws
Power Drills
Hydraulic/Arbor Press
Heat Treatment Equipment
Hardness Testing Equipment
Grinding Machines with Attachments
Welding Equipment (SMAW, GMAW, FCAW, Plasma)
CNC Machining Center and Turning Center
Gear Producing Machines with Attachments
Jig Boring Machines
Alignment/Calibration Tools
Coolant Recovery Equipment
Computer
Ventilation Equipment
Forklift
Personal Safety Equipment
Oxyacetylene Equipment
Tool Storage Equipment
Workbenches
Vises
Pedestal Grinders
Weld Test Equipment
Optical Comparator
Coordinate Measurement Machine
Hydraulic/Pneumatic Training Equipment
Electrical Training Equipment
Safety Training Equipment

**CURRENT TRENDS/CONCERNS**

Statistical Process Control
Composites
Laser Machining
Advanced Computer Applications
Robotics
Environmental Concerns
Fiber Optic Controls
Automated Material Handling Equipment
Computer Integrated Manufacturing

## COMPETENCY PROFILE

# Computer-Aided Manufacturing and Advanced CNC Technician

**Prepared By**
**M.A.S.T.**
**Machine Tool Advanced Skills Technology Program**
**and**
**Consortium Partners**
**(V.199J40008)**

***M*achine Tool *A*dvanced *S*kills *T*echnology Program**

**MAST**

**CAD/CAM and CNC MACHINIST**.... **program, edit, setup, and operate CNC lathes, mills and grinders to perform machining operations necessary to produce workpieces to referenced engineering standards.**

| Duties | Tasks | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| A Practice Safety | A-1 Use proper safety equipment | A-2 Identify proper clothing | A-3 State proper attitudes for safety | A-4 Handle chemicals properly | A-5 Identify fire hazards in machining | A-6 Demonstrate proper personal hygiene | A-7 Demonstrate proper laboratory cleaning | | | | | | |
| B Perform Measurements | B-1 Identify applications and limitations of measuring instruments | B-2 Demonstrate use of measuring instruments | | | | | | | | | | | |
| C Apply Mathematical Concepts | C-1 Perform mathematical computations with calculator | C-2 Calculate fractions and decimals with calculator | C-3 Convert Metric and US standard units of measure | C-4 Perform RPM calculations | C-5 Perform feed calculations | C-6 Perform depth of cut calculations | C-7 Perform thread cutting calculations | C-8 Perform tap drill calculations | C-9 Interpret reference tables related to machining | C-10 Apply Cartesian coordinate system in machining | C-11 Perform trigonometric calculations | C-12 Perform Pythagorean Theorem calculations | C-13 Perform polar trigonometry calculations |
| D Read Blueprints | D-1 Describe types of blueprint drawings | D-2 Describe blueprint dimensions | D-3 Interpret title, notes, revision and material information | D-4 Interpret blueprint drawings | | | | | | | | | |
| E Program CNC Machines & EDM | E-1 Demonstrate cutting tool identification and application | E-2 Identify and describe machine operation nomenclature | E-3 Identify and describe essentials of CNC systems | E-4 Identify and describe types of CNC hardware and software | E-5 Identify and describe machine axes and coordinate systems | E-6 Describe and interpret CNC coding systems | E-7 Write NC programs | E-8 Plan process for NC operations | E-9 Demonstrate use of electronic discharge machine (EDM) | | | | |
| F Operate CNC Machines & EDM | F-1 Describe vertical machining process and safety | F-2 Describe vertical machining functions | F-3 Set-up and program operation of vertical machine | F-4 Demonstrate machining of objects on vertical machining center | F-5 Perform advance EDM operations | F-6 Describe turning process, equipment, and safety | F-7 Describe turning center | F-8 Set-up and program operation of turning center | F-9 Demonstrate machining objects on turning center | | | | |
| G Use Computers | G-1 Demonstrate use of computer hardware | G-2 Select/use computer operating systems | G-3 Demonstrate use of basic DOS commands | G-4 Demonstrate use of Windows and Windows NT commands | G-5 Demonstrate use of MACROS in Windows and Windows NT programs | G-6 Demonstrate use of computer communication systems | | | | | | | |
| H Use CNC Verification Programs | H-1 Identify CNC verification software programs | H-2 Program and create CNC verification using program icons | H-3 Program CNC verification using pull-down menus | | | | | | | | | | |
| I Use CAD/CAM Programs | I-1 Demonstrate understanding of CAD/CAM programs | I-2 Access CAD program options | I-3 Create designs with CAD section of CAD/CAM program | I-4 Demonstrate ability to use program functions | I-5 Process tool path data | | | | | | | | |





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# THE MAST TECHNICAL WORKPLACE COMPETENCY OUTLINE

The Competency Profiles derived from the industry survey process were returned to industry and faculty members at each MAST partner college for review. Reviewers were asked to identify specific sub-tasks within each block of Duties and Tasks in the Profile; MAST staff at each college broke the sub-tasks down further into the detailed steps required to actually perform the duties and tasks of the manufacturing process. It is these detailed skill standards that were then incorporated into development of the curriculum and piloted as a training program by each of the MAST colleges. All results for the specific occupational specialty area have been organized as an outline of the duties, tasks, and sub-tasks required to demonstrate technical competency in the workplace, as shown in the following pages.

As a result of the Texas and the National Surveys, additional refinements were made to the Competency Outlines. These changes were then incorporated into the individual course syllabi.

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The MAST Technical Workplace Competency Outline for this occupational specialty area has been included on the following pages.

# COMPUTER-AIDED MANUFACTURING AND ADVANCED CNC TECHNICIAN

## TECHNICAL WORKPLACE COMPETENCIES

**CAM AND CNC TECHNICIAN**...*program, edit, setup, and operate CNC lathes, mills and grinders to perform machining operations necessary to produce work pieces to referenced engineering standards.*

**A. PRACTICE SAFETY**

1. Use proper safety equipment
2. Identify proper clothing
3. State proper attitudes for safety
4. Handle chemicals properly
5. Identify fire hazards in machining
6. Demonstrate proper personal hygiene
7. Demonstrate proper laboratory cleaning

**B. PERFORM MEASUREMENTS**

1. Identify applications and limitations of measuring instruments
2. Demonstrate use of measuring instruments

**C. APPLY MATHEMATICAL CONCEPTS**

1. Perform mathematical computations with calculator
2. Calculate fractions and decimals with calculator
3. Convert Metric and US standard units of measure
4. Perform RPM calculations
5. Perform feed calculations
6. Perform depth of cut calculations
7. Perform thread cutting calculations
8. Perform tap drill calculations
9. Interpret reference tables related to machining
10. Apply Cartesian coordinate system in machining
11. Perform trigonometric calculations
12. Perform Pythagorean Theorem calculations
13. Perform polar trigonometry calculations

**D. READ BLUEPRINTS**

1. Describe types of blueprint drawings
2. Describe blueprint dimensions
3. Interpret title, notes, revision and material information
4. Interpret blueprint drawings

**E. PROGRAM CNC MACHINES & EDM**

1. Demonstrate cutting tool identification and application
2. Identify and describe machine operation nomenclature
3. Identify and describe essentials of CNC systems
4. Identify and describe types of CNC hardware and software

5. Identify and describe machine axes and coordinate systems
6. Describe and interpret CNC coding systems
7. Write NC programs
8. Plan process for NC operations
9. Demonstrate use of electronic discharge machine (EDM)

**F. OPERATE CNC MACHINES & EDM**

1. Describe vertical machining process and safety
2. Describe vertical machining functions
3. Set-up and program operation of vertical machine
4. Demonstrate machining of objects on vertical machining center
5. Perform advance EDM operations
6. Describe CNC turning process, equipment and safety
7. Describe turning center
8. Set-up and program operation of turning center
9. Demonstrate machining of objects on turning center

**G. USE COMPUTERS**

1. Demonstrate use of computer hardware
2. Select/use computer operating systems
3. Demonstrate use of basic DOS commands
4. Demonstrate use of Windows and Windows NT commands
5. Demonstrate use of MACROS in Windows and Windows NT programs
6. Demonstrate use of computer communication systems

**H. USE CNC VERIFICATION PROGRAMS**

1. Identify CNC verification software programs
2. Program and create CNC verification using program icons
3. Program CNC verification using pull-down menus

**I. USE CAD/CAM PROGRAMS**

1. Demonstrate understanding CAD/CAM programs
2. Access CAD program options
3. Create designs with CAD section of CAD/CAM program
4. Demonstrate ability to use program functions
5. Process tool path data

# THE MAST PILOT PROGRAM CURRICULUM AND COURSE DESCRIPTIONS

After completing the Competency Profile and Technical Workplace Competency Outline for each occupational specialty area, each MAST partner reviewed their existing curricula against the industry-verified skill standards in order to identify a suitable foundation for new pilot training programs. Because each college had to comply with the requirements of its respective college system and appropriate state agency, the resulting pilot curricula for occupational specialty areas tended to vary in format and academic requirements (e.g., some programs were based on the semester system, others on the quarter system). Despite differences in the curricula developed at the partner colleges, each of the pilot programs was designed to achieve the following two goals mandated in the MAST grant proposal:

- Pilot Program: "Conduct a one year pilot program with 25 or more selected applicants at each college or advanced technology center to evaluate laboratory content and effectiveness, as measured by demonstrated competencies and indicators of each program area."

- Student Assessment: "Identify global skills competencies of program applicants both at point of entrance and point of exit for entry level and already-employed technicians."

(Note: All occupational specialty areas were not pilot tested at all Development Centers; however, all partner colleges conducted one or more pilot programs.)

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Included on the following pages is the curriculum listing for the pilot program which was used to validate course syllabi for this occupational specialty area. This curriculum listing included course names and numbers from the college which conducted the pilot program. The curriculum also shows the number of hours assigned to each of the courses (lecture, lab and credit hours). Also included is a description of each of the courses. Also included in this section is a recommended list of tools, equipment and supplies which should be furnished by the school. This items on this list will be needed in addition to the tool list found in each of the course syllabi.

**MANUFACTURING TECHNOLOGY**
**COMPUTER-AIDED MANUFACTURING**
**AND ADVANCED CNC TECHNOLOGY**
**CURRICULUM**
**1995-1996**

| | | LEC | LAB | CR |
|---|---|---|---|---|
| MACT 140 | Basic Principles of Machine Technology | 3 | 3 | 4 |
| MACT 150 | Introduction to CNC and EDM | 3 | 3 | 4 |
| MACT 151 | Introduction to CNC Verification and Communication | 3 | 3 | 4 |
| MACT 160 | Introduction to CAD/CAM | 3 | 3 | 4 |
| MACT 161 | Applications of CAD/CAM I | 0 | 6 | 2 |
| MACT 170 | Introduction to CNC Controlled Vertical Machining and Electronic Discharge Machining (E.D.M.) | 3 | 3 | 4 |
| MACT 171 | Application of CNC Controlled Vertical Machining and Electronic Discharge Machining (E.D.M.) I | 0 | 6 | 2 |
| MACT 180 | Advanced CAD/CAM | 3 | 3 | 4 |
| MACT 181 | Application in Advanced CAD/CAM I | 0 | 6 | 2 |
| MACT 190 | Introduction to CNC Controlled Turning | 3 | 3 | 4 |
| MACT 191 | Applications of CNC Controlled Turning I | 0 | 6 | 2 |
| | Program Totals | 21 | 45 | 36 |

**MANUFACTURING TECHNOLOGY**
**COMPUTER-AIDED MANUFACTURING**
**AND ADVANCED CNC OPTION**
**COURSE DESCRIPTIONS 1995-1996**

**MACT 140** **Basic Principles of Machine Technology** (3-3-4) This course offers the basic principles required in the Machine Technology field in regard to measurements, common formulas, machining applications, safety, and interpretation of basic drawings. No prerequisite.

**MACT 150** **Introduction to CNC and EDM** (3-3-4) The theory of advanced machining techniques, including NC mills and lathes and EDM. Emphasis on introduction to CNC programming using "G" and "M" codes. Prerequisite is previous machine shop experience, concurrent enrollment in City College machine shop, or permission of the instructor.

**MACT 151** **Introduction to CNC Verification and Communication** (3-3-4) Theory and application of verification and communication of CNC programs. Prerequisite is satisfactory completion of MACT 150, Introduction to CNC and EDM, concurrent enrollment in MACT 150, Introduction to CNC and EDM, or permission of the instructor.

**MACT 160** **Introduction to CAD/CAM** (3-3-4) Introduction to CAD/CAM theories and software. Emphasis on generation of basic CNC programs for CNC mill and CNC lathe. Prerequisite is satisfactory completion of MACT 150, Introduction to CNC and EDM and MACT 151, Introduction to CNC Verification and Communication, or by permission of instructor.

**MACT 161** **Applications of CAD/CAM I** (0-6-2) Exercises in CAD/CAM to increase student efficiency and quality of work on generation of CNC programs, at an increased level, for CNC mill and lathe. Prerequisite is satisfactory completion of MACT 150, introduction to CNC and EDM, MACT 151, Introduction to CNC Verification and Communication, and MACT 160, Introduction to CAD/CAM, or concurrent enrollment, or by permission of instructor

**MACT 170** **Introduction to CNC Controlled Vertical Machining and Electronic Discharge Machining (E.D.M.)** (3-3-4) The theory of CNC vertical machining techniques. Emphasis placed on basic operations of vertical machining center and EDM. Prerequisite is previous machine shop experience, satisfactory completion of MACT 150, Introduction to CNC and EDM, or concurrent enrollment, or by permission of instructor.

**MACT 171** **Application of CNC Controlled Vertical Machining and Electronic Discharge Machining (E.D.M.) I** (0-6-2) Exercises in CNC vertical machining techniques,

and EDM. Class will allow students the opportunity to develop speed and efficiency in hands-on environment. Prerequisite is previous machine shop experience, satisfactory completion of MACT 150, Introduction to CNC and EDM, and MACT 170, Introduction to CNC Controlled Vertical Machining and Electronic Discharge Machining (E.D.M.), or by permission of instructor.

MACT 180 **Advanced CAD/CAM** (3-3-4) Advanced CAD/CAM theory and software. Emphasis on generation of advanced CNC programs for both CNC mill and lathe. Transfer credit for California State University system. Prerequisites are (1) satisfactory completion of MACT 160, Introduction to CAD/CAM, with the ability to create basic "2D" CAD/CAM drawings, and to create basic CAD/CAM-generated programs; and (2) the ability to create "3D" CAD/CAM drawings, and to create surfaces and programs according to machining theory.

MACT 181 **Applications in Advanced CAD/CAM I** (0-6-2) Exercises in CAD/CAM theory and software at an intermediate level. Emphasis on generation of CNC programs at intermediate level for both CNC mill and lathe. The class is designed to allow students the opportunity to work independently in the application of intermediate CAD/CAM, in order to increase speed, efficiency, quantity, and quality of work using advanced surfaces. Transfer credit for California State University system. Prerequisites are satisfactory completion of MACT 180, Advanced CAD/CAM, with the ability to create "3D" models and surfaces; and to create CNC programs to machine 3D models and surfaces.

MACT 190 **Introduction to CNC Controlled Turning** (3-3-4) Theory of CNC turning techniques. Emphasis placed on basic operations of CNC turning. Prerequisite is previous machine shop experience, satisfactory completion of MACT 150, Introduction to CNC and EDM, and MACT 151, Introduction to CNC Verification and Communication, or permission of the instructor.

MACT 191 **Applications of CNC Controlled Turning I** (0-6-2) Exercises in CNC turning techniques at an intermediate level. Emphasis on basic operations of CNC turning. The class is designed to allow students the opportunity to gain speed and efficiency in the hands-on application of turning operations at an intermediate level. Transfer credit for California State University system. Prerequisite is previous machine shop experience, satisfactory completion of MACT 150, Introduction to CNC and EDM, and MACT 151, Introduction to CNC Verification and Communication, or permission of the instructor.

# THE MAST TECHNICAL WORKPLACE COMPETENCY/COURSE CROSSWALK

Upon development of appropriate curricula for the pilot programs, each MAST college began to develop individual course outlines for its assigned specialty area. The skill standards identified in the Competency Profile were cross walked against the technical competencies of the courses in the pilot curriculum. The resulting matrix provided a valuable tool for assessing whether current course content was sufficient or needed to be modified to ensure mastery of entry level technical competencies. Exit proficiency levels for each of the technical competencies were further validated through industry wide surveys both in Texas and across the nation.

The Technical Workplace Competency/Course Crosswalk in the following pages presents the match between industry-identified duties and tasks and the pilot curriculum for . Course titles are shown in columns, duties and tasks in rows. The Exit Level Proficiency Scale, an ascending scale with 5 the highest level of proficiency, includes marked boxes indicating whether the task is covered by the instructor during the course; the numbers 1-5 indicate the degree of attention given to the task and the corresponding proficiency expected on the part of the student. The crosswalk is intended to serve as an aide to other instructional designers and faculty in community college programs across the nation.

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Included on the following pages is the Technical Workplace Competency/Course Crosswalk for the pilot program curriculum. This crosswalk validates the fact that the duties and tasks which were identified by industry as being necessary for entry level employees have been incorporated into the development of the course syllabi.

*Technical Workplace Competencies/Course*

# CROSSWALK

## TECHNICAL COMPETENCY COMPUTER-AIDED MANUFACTURING AND ADVANCED CNC TECHNICIAN

| | Basic Principles of Machine Technology | Intro to CNc and EDM | Intro to CNC Math&Communication | Intro to CADCAM | Applications of CADCAM I | Intro to CNC Controlled Vert. Mach.EDM | Applications-CNC Controlled Vert. Mach.EDM | Advanced CADCAM | Application in Advanced CADCAM I | Intro to CNC Controlled Turning | Applications of CNC Controlled Turning I | | | | EXIT PROFICIENCY LEVEL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **A. PRACTICE SAFETY** | | | | | | | | | | | | | | | |
| A-1 Use Proper Safety Equipment | X | X | X | X | X | X | X | X | X | X | X | | | | 5 |
| A-2 Identify Proper Clothing | X | X | X | X | X | X | X | X | X | X | X | | | | 4 |
| A-3 State Proper Attitudes for Safety | X | X | X | X | X | X | X | X | X | X | X | | | | 5 |
| A-4 Handle Chemicals Properly | X | X | X | X | X | X | X | X | X | X | X | | | | 4 |
| A-5 Identify Fire Hazards in Machining | X | X | X | X | X | X | X | X | X | X | X | | | | 4 |
| A-6 Demonstrate Proper Personal Hygiene | X | X | X | X | X | X | X | X | X | X | X | | | | 5 |
| A-7 Demonstrate Proper Laboratory Cleaning | X | X | X | X | X | X | X | X | X | X | X | | | | 4 |
| **B. PERFORM MEASUREMENTS** | | | | | | | | | | | | | | | |
| B-1 Identify Applications and Limitations of Measuring Instruments | X | X | X | X | X | X | X | X | X | X | X | | | | 4 |
| B-2 Demonstrate Use of measuring Instruments | X | X | X | X | X | X | X | X | X | X | X | | | | 4 |
| **C. APPLY MATHEMATICAL CONCEPTS** | | | | | | | | | | | | | | | |
| C-1 Perform Mathematical Computations With Calculator | X | X | X | X | X | X | X | X | X | X | X | | | | 4 |
| C-2 Calculate Fractions and Decimals With Calculator | X | X | X | X | X | X | X | X | X | X | X | | | | 4 |
| C-3 Convert Metric and US Standard Units of Measure | X | X | X | X | X | X | X | X | X | X | X | | | | 4 |
| C-4 Perform RPM Calculations | X | X | X | X | X | X | X | X | X | X | X | | | | 4 |
| C-5 Perform Feed Calculations | X | X | X | X | X | X | X | X | X | X | X | | | | 4 |
| C-6 Perform Depth of Cut Calculations | X | X | X | X | X | X | X | X | X | X | X | | | | 4 |
| C-7 Perform Thread Cutting Calculations | X | X | X | X | X | X | X | X | X | X | X | | | | 4 |
| C-8 Perform Tap Drill Calculations | X | X | X | X | X | X | X | X | X | X | X | | | | 4 |
| C-9 Interpret Reference Tables Related to Machining | X | X | X | X | X | X | X | X | X | X | X | | | | 4 |
| C-10 Apply Cartesian Coordinate System in Machining | X | X | X | X | X | X | X | X | X | X | X | | | | 4 |
| C-11 Perform Trigonometric Calculations | X | X | X | X | X | X | X | X | X | X | X | | | | 4 |
| C-12 Perform Pythagorean Theorem Calculations | X | X | X | X | X | X | X | X | X | X | X | | | | 4 |
| C-13 Perform Polar Trigonometry Calculations | X | X | X | X | X | X | X | X | X | X | X | | | | 4 |
| **D. READ BLUEPRINTS** | | | | | | | | | | | | | | | |
| D-1 Describe Types of Blueprint Drawings | X | X | X | X | X | X | X | X | X | X | X | | | | 4 |
| D-2 Describe Blueprint Dimensions | X | X | X | X | X | X | X | X | X | X | X | | | | 4 |
| D-3 Interpret Title, Notes, Revision and Material Information | X | X | X | X | X | X | X | X | X | X | X | | | | 4 |
| D-4 Interpret Blueprint Drawings | X | X | X | X | X | X | X | X | X | X | X | | | | 4 |

*Technical Workplace Competencies/Course*

# CROSSWALK

## TECHNICAL COMPETENCY COMPUTER-AIDED MANUFACTURING AND ADVANCED CNC TECHNICIAN

| | Basic Principles of Machine Technology | Intro to CNC and EDM | Intro to CNC Verification/Communication | Intro to CAD/CAM | Applications of CAD/CAM I | Intro to CNC Controlled Vert. Mach./EDM | Applications-CNC Controlled Vert. Mach./EDM | Advanced CAD/CAM | Application in Advanced CAD/CAM I | Intro to CNC Controlled Turning | Application of CNC Controlled Turning I | | | | EXIT PROFICIENCY LEVEL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **E. PROGRAM MACHINES & EDM** | | | | | | | | | | | | | | | |
| E-1 Demonstrate Cutting Tool Identification and Application | | X | X | X | X | X | X | X | X | X | X | | | | 4 |
| E-2 Identify and Describe Machine Operation Nomenclature | | X | X | X | X | X | X | X | X | X | X | | | | 4 |
| E-3 Identify and Describe Essentials of CNC Systems | | X | X | X | X | X | X | X | X | X | X | | | | 4 |
| E-4 Identify and Describe Types of CNC Hardware and Software | | X | X | X | X | X | X | X | X | X | X | | | | 4 |
| E-5 Identify and Describe Machine Axes and Coordinate Systems | | X | X | X | X | X | X | X | X | X | X | | | | 4 |
| E-6 Describe and Interpret CNC Coding Systems | | X | | | | X | X | | | X | X | | | | 4 |
| E-7 Write NC Programs | | X | | | | X | X | | | X | X | | | | 5 |
| E-8 Plan Process for NC Operations | | X | X | X | X | X | X | X | X | X | X | | | | 5 |
| E-9 Demonstrate Use of Electronic Discharge Machine (EDM) | | X | | | | X | X | | | | | | | | 5 |
| **F. OPERATE CNC MACHINES & EDM** | | | | | | | | | | | | | | | |
| F-1 Describe Vertical Machining Process and Safety | | X | | | | X | X | | | | | | | | 4 |
| F-2 Describe Vertical Machining Functions | | X | | | | X | X | | | | | | | | 5 |
| F-3 Set-up and Program Operation of Vertical Machine | | X | | | | X | X | | | | | | | | 5 |
| F-4 Demonstrate Machining of Objects on Vertical Machining Center | | X | | | | X | X | | | | | | | | 5 |
| F-5 Perform Advanced EDM Operations | | X | | | | X | X | | | | | | | | 4 |
| F-6 Describe CNC Turning Process, Equipment and Safety | | X | | | | | | | X | X | | | | | 5 |
| F-7 Describe Turning Center | | X | | | | | | | X | X | | | | | 5 |
| F-8 Set-up and Program Operation of Turning Center | | X | | | | | | | X | X | | | | | 5 |
| F-9 Demonstrate Machining of Objects on Turning Center | | X | | | | | | | X | X | | | | | 5 |
| **G. USE COMPUTERS** | | | | | | | | | | | | | | | |
| G-1 Demonstrate Use of Computer Hardware | | X | X | X | X | X | X | X | X | X | X | | | | 5 |
| G-2 Select/Use Computer Operating Systems | | | X | X | X | X | X | X | X | X | X | | | | 5 |
| G-3 Demonstrate Use of Basic DOS Commands | | | X | X | X | X | X | X | X | X | X | | | | 4 |
| G-4 Demonstrate Use of Windows and Windows NT Commands | | | X | X | X | X | X | X | X | X | X | | | | 4 |
| G-5 Demonstate Use of MACROS in Windows and Windows NT Programs | | | X | X | X | X | X | X | X | X | X | | | | 4 |
| G-6 Demonstrate Use of computer Communication Systems | | | X | X | X | X | X | X | X | X | X | | | | 4 |
| **H. USE CNC VERIFICATION PROGRAMS** | | | | | | | | | | | | | | | |
| H-1 Identify CNC Verification Software Programs | | | X | X | X | X | X | X | X | X | X | | | | 5 |
| H-2 Program and Create CNC Verification Using Program Icons | | | X | X | X | X | X | X | X | X | X | | | | 5 |

*Technical Workplace Competencies/Course*

# CROSSWALK

## TECHNICAL COMPETENCY COMPUTER-AIDED MANUFACTURING AND ADVANCED CNC TECHNICIAN

| | Basic Principles of Machine Technology | Intro to CNC and EDM | Intro to CNC Verification/Communication | Intro to CAD/CAM | Applications of CAD/CAM I | Intro to CNC Controlled Vert. Mach./EDM | Applications CNC Controlled Vert. Mach./EDM | Advanced CAD/CAM | Application in Advanced CAD/CAM I | Intro to CNC Controlled Turning | Applications of CNC Controlled Turning I | | | EXIT PROFICIENCY LEVEL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| H-3 Program CNC Verification Using Pull-Down Menus | | | X | | | | | | | | | | | 5 |
| **I. USE CAD/CAM PROGRAMS** | | | | | | | | | | | | | | |
| I-1 Demonstrate Understanding of CAD/CAM Programs | | | | X | X | | | X | X | | | | | 5 |
| I-2 Access CAD Program Options | | | | X | X | | | X | X | | | | | 5 |
| I-3 Create Designs With CAD Section of CAD/CAM Program | | | | X | X | | | X | X | | | | | 5 |
| I-4 Demonstrate Ability to Use Program Functions | | | | X | X | | | X | X | | | | | 5 |
| I-5 Process Tool Path Data | | | | X | X | | | X | X | | | | | 5 |

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# COMPUTER-AIDED MANUFACTURING AND ADVANCED CNC TECHNICIAN TECHNICAL WORKPLACE COMPETENCIES EXIT LEVEL PROFICIENCY MATRIX

CAM and CNC Technician: program, edit, setup, and operate CNC lathes, mills and grinders to perform machining operations necessary to produce work pieces to referenced engineering standards.

The following matrix identifies the five exit levels of technical workplace competencies for the CAM and CNC Technician Certificate at San Diego City College, Center for Applied Competitive Technologies, San Diego, California.

| EXIT LEVEL OF PROFICIENCY | | | | | |
|---|---|---|---|---|---|
| **Technical Workplace Competency** | **1** | **2** | **3** | **4** | **5** |
| | rarely | routinely with supervision | routinely with limited supervision | routinely without supervision | initiates/ improves/ modifies and supervises others |

# THE MAST SCANS/COURSE CROSSWALK

The Secretary's Commission on Achieving Necessary Skills (SCANS), U. S. Department of Labor, has identified in its "AMERICA 2000 REPORT' the following five competencies and a three-part foundation of skills and personal qualities that are needed for solid job performance:

**COMPETENCIES:**

| | |
|---|---|
| Resources: | Identifies, organizes, plans, and allocates resources |
| Interpersonal: | Works with others |
| Information: | Acquires and uses information |
| Systems: | Understands complex inter-relationships |
| Technology: | Works with a variety of technologies |

**FOUNDATION SKILLS:**

| | |
|---|---|
| Basic Skills: | Reads, writes, performs arithmetic and mathematical operations, listens and speaks |
| Thinking Skills: | Thinks creatively, makes decisions, solves problems, visualizes, knows how to learn and reasons |
| Personal Qualities: | Displays responsibility, self-esteem, sociability, self-management, and integrity and honesty |

Recognizing the value of SCANS proficiencies to job performance, as well as the growing mandate in many states to include SCANS activities in course curricula, MAST asked survey respondents to review the SCANS skill sets in the context of the draft skill standards for each occupational specialty area. MAST also incorporated evaluation of SCANS competencies and foundation skills into its assessment of the pilot training curricula. The results were summarized in a crosswalk that allowed MAST staff to modify course content where needed to strengthen achievement of SCANS competencies.

The following pages present the SCANS/Course Crosswalk for the pilot curriculum in Courses are listed along the top and SCANS competencies and foundations are shown along the left side of the matrix. An exit level proficiency matrix for SCANS competencies and foundation skills is provided as well.

As "soft" skills, the SCANS competencies are inherently difficult to quantify. MAST realizes that some faculty will emphasize the SCANS more or less than others. The SCANS/Course Crosswalk matrix has been included with this course documentation to show the importance of these "soft skills" and the importance of their being addressed in the classroom (particularly in technical classes). In time, faculty will learn to make these types of SCANS activities an integral and important part of the teaching process.

Included on the following pages is the SCANS/Course Crosswalk for the pilot program curriculum. This crosswalk validates the fact that the "soft skills" (SCANS) which were identified by industry as being necessary for entry level employees have been incorporated into the development of the course syllabi. Also included is a matrix which defines the exit level of proficiency scale (1-5).

## SCANS/COURSE CROSSWALK

The skill survey incorporated a modified version of the five work-related competencies and three foundation skills identified in the 1991 Report of the Secretary of Labor's Commission on Achieving Necessary Skills (SCANS). Survey respondents were asked to review two SCANS skill sets -- i.e., Skills and Knowledge, and Traits and Attitudes -- presented in the context of the draft CAM/CNC Technician skill standards.

With one exception, the surveyed companies did not vary in their selection of desired Skills and Knowledge in prospective workers. All of the surveyed companies identified the following set of Skills and Knowledge:

-- communication skills
-- use measurement tools
-- use inspection devices
-- mathematical skills
-- reading/writing skills
-- knowledge of safety regulations
-- practice safety in the workplace
-- organizational skills
-- knowledge of company policies/procedures
-- mechanical aptitude
-- ability to comprehend written/verbal instructions
-- basic knowledge of fasteners
-- ability to work as part of a team
-- converse in the technical language of the trade
-- knowledge of occupational opportunities
-- knowledge of employee/employer responsibilities
-- knowledge of company quality assurance activities
-- practice quality-consciousness in job performance

With one exception, the surveyed companies also did not vary in their selection of desired Traits and Attitudes in prospective workers. All companies surveyed desired employees to model the following Traits and Attitudes:

-- strong work ethic
-- interpersonal skills
-- punctuality
-- dependability
-- honesty
-- neatness
-- safety conscientiousness
-- motivation
-- responsibility
-- physical ability
-- professionalism
-- trustworthiness

-- customer relations
-- personal ethics

Taylor Guitar, reflecting both its craftsperson leaning and the personality of its plainspoken founder and president, added to the above list:

-- candor
-- knowing how to make things
-- having a feel for machines
-- affinity for a shop
-- pass a 6 to 8 hour skills test in 3 or 4 different departments

See Appendix 1 for detailed list of SCANS competencies and skills by individual company Competency Profile.

*SCANS/Course*

# CROSSWALK

## TECHNICAL COMPETENCIES
## COMPUTER-AIDED MANUFACTURING AND ADVANCED CNC TECHNICIAN

| COMPETENCY | Basic Principles of Machine Technology | Intro to Computer Numerical Control (CNC) and Electrical Discharge Machining (EDM) | Intro to CNC Verification and Communication | Intro to CADICAM | Applications of CADICAM I | Intro to CNC Controlled Vert. Mach. and Electronic Discharge Machining (EDM) | Applications of CNC Controlled Vert. Mach. and Electronic Discharge Machining (EDM) I | Advanced CADICAM I | Application in Advanced CADICAM I | Intro to CNC Controlled Turning | Applications of CNC Controlled Turning I | | | | EXIT PROFICIENCY LEVEL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **(RS) RESOURCES:** | | | | | | | | | | | | | | | |
| A. Allocates time | X | X | X | X | X | X | X | X | X | X | X | | | | 4 |
| B. Allocates money | | X | X | X | X | X | X | X | X | X | X | | | | 2 |
| C. Allocates material and facility resources | X | X | X | X | X | X | X | X | X | X | X | | | | 4 |
| D. Allocates human resources | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | |
| **(IN) INTERPERSONAL SKILLS:** | | | | | | | | | | | | | | | |
| A. Participates as a member of a team | X | X | X | X | X | X | X | X | X | X | X | | | | 4 |
| B. Teaches others | X | X | X | X | X | X | X | X | X | X | X | | | | 4 |
| C. Serves clients/customers | | | | | | | | | | | | | | | |
| D. Exercises leadership | X | X | X | X | X | X | X | X | X | X | X | | | | 1 |
| E. Negotiates | X | X | X | X | X | X | X | X | X | X | X | | | | 4 |
| F. Works with cultural diversity | X | X | X | X | X | X | X | X | X | X | X | | | | 5 |
| | | | | | | | | | | | | | | | |
| **(IF) INFORMATION SKILLS:** | | | | | | | | | | | | | | | |
| A. Acquires and evaluates information | X | X | X | X | X | X | X | X | X | X | X | | | | 5 |
| B. Organizes and maintains information | X | X | X | X | X | X | X | X | X | X | X | | | | 5 |
| C. Interprets and communicates information | X | X | X | X | X | X | X | X | X | X | X | | | | 5 |
| D. Uses computers to process information | X | X | X | X | X | X | X | X | X | X | X | | | | 5 |
| | | | | | | | | | | | | | | | |
| **(SY) SYSTEMS:** | | | | | | | | | | | | | | | |
| A. Understands systems | X | X | X | X | X | X | X | X | X | X | X | | | | 5 |
| B. Monitors and corrects performance | X | X | X | X | X | X | X | X | X | X | X | | | | 5 |
| C. Improves and designs systems | X | X | X | X | X | X | X | X | X | X | X | | | | 1 |
| | | | | | | | | | | | | | | | |
| **(TE) TECHNOLOGY:** | | | | | | | | | | | | | | | |
| A. Selects technology | X | X | X | X | X | X | X | X | X | X | X | | | | 5 |
| B. Applies technology to task | X | X | X | X | X | X | X | X | X | X | X | | | | 5 |
| C. Maintains and troubleshoots technology | X | X | X | X | X | X | X | X | X | X | X | | | | 3 |
| | | | | | | | | | | | | | | | |

*SCANS/Course*

# CROSSWALK
## TECHNICAL COMPETENCIES
## COMPUTER-AIDED MANUFACTURING AND ADVANCED CNC TECHNICIAN

| FOUNDATION SKILLS | Basic Principles of Machine Technology | Intro to Computer Numerical Control (CNC) and Electrical Discharge Machining (EDM) | Intro to CNC Verification and Communication | Intro to CADICAM | Applications of CADICAM I | Intro to CNC Controlled Vert. Mach. and Electronic Discharge Machining (EDM) | Applications of CNC Controlled Vert. Mach. and Electronic Discharge Machining (EDM) | Advanced CADICAM I | Application in Advanced CADICAM I | Intro to CNC Controlled Turning | Applications of CNC Controlled Turning I | | | | EXIT PROFICIENCY LEVEL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **(BS) BASIC SKILLS:** | | | | | | | | | | | | | | | |
| A. Reading | X | X | X | X | X | X | X | X | X | X | X | | | | 5 |
| B. Writing | X | X | X | X | X | X | X | X | X | X | X | | | | 5 |
| C. Arithmetic and mathematics | X | X | X | X | X | X | X | X | X | X | X | | | | 4 |
| D. Listening | X | X | X | X | X | X | X | X | X | X | X | | | | 4 |
| E. Speaking | X | X | X | X | X | X | X | X | X | X | X | | | | 4 |
| | | | | | | | | | | | | | | | |
| **(TS) THINKING SKILLS:** | | | | | | | | | | | | | | | |
| A. Creative thinking | X | X | X | X | X | X | X | X | X | X | X | | | | 5 |
| B. Decision making | X | X | X | X | X | X | X | X | X | X | X | | | | 4 |
| C. Problem solving | X | X | X | X | X | X | X | X | X | X | X | | | | 5 |
| D. Seeing things in the mind's eye | X | X | X | X | X | X | X | X | X | X | X | | | | 5 |
| E. Knowing how to learn | X | X | X | X | X | X | X | X | X | X | X | | | | 5 |
| F. Reasoning | X | X | X | X | X | X | X | X | X | X | X | | | | 5 |
| | | | | | | | | | | | | | | | |
| **(PQ) PERSONAL QUALITIES:** | | | | | | | | | | | | | | | |
| A. Responsibility | X | X | X | X | X | X | X | X | X | X | X | | | | 5 |
| B. Self-esteem | X | X | X | X | X | X | X | X | X | X | X | | | | 5 |
| C. Social | X | X | X | X | X | X | X | X | X | X | X | | | | 5 |
| D. Self-management | X | X | X | X | X | X | X | X | X | X | X | | | | 5 |
| E. Integrity/honesty | X | X | X | X | X | X | X | X | X | X | X | | | | 5 |

# SCANS
## COMPETENCIES AND FOUNDATION SKILLS
## EXIT LEVEL PROFICIENCY MATRIX

The Secretary's Commission on Achieving Necessary Skills (SCANS), U. S. Department of Labor, has identified in its "AMERICA 2000 REPORT' the following five competencies and a three-part foundation of skills and personal qualities that are needed for solid job performance:

**COMPETENCIES:**

| | |
|---|---|
| Resources: | Identifies, organizes, plans, and allocates resources |
| Interpersonal: | Works with others |
| Information: | Acquires and uses information |
| Systems: | Understands complex inter-relationships |
| Technology: | Works with a variety of technologies |

**FOUNDATION SKILLS:**

| | |
|---|---|
| Basic Skills: | Reads, writes, performs arithmetic and mathematical operations, listens and speaks |
| Thinking Skills: | Thinks creatively, makes decisions, solves problems, visualizes, knows how to learn and reasons |
| Personal Qualities: | Displays responsibility, self-esteem, sociability, self-management, and integrity and honesty. |

The following matrix identifies the five exit levels of proficiency that are needed for solid job performance.

| EXIT LEVEL OF PROFICIENCY | | | | | |
|---|---|---|---|---|---|
| **SCANS Competencies and Foundation Skills** | **1** | **2** | **3** | **4** | **5** |
| | rarely | routinely with supervision | routinely with limited supervision | routinely without supervision | initiates/ improves/ modifies and supervises others |

MAST/05/012296

# THE MAST COURSE SYLLABI
# "PILOT PROGRAM"

MAST has produced a very unique set of course outlines, driven and validated by industry and encompassing the broad range of technologies covered by the MAST grant. The course outlines also include proposed SCANS activities that will be useful to an instructor in preparing students to enter the workforce of the future.

Included in the following pages are final course outlines developed and refined in the process of piloting the MAST training programs. The outlines include a brief course description; required course materials (e.g., textbook, lab manual, and tools, if available); proposed method of instruction; proposed lecture and lab outlines; and detailed course objectives for both Technical Workplace Competencies and SCANS Competencies.

These outlines were completed and revised during the second year of MAST, following completion of the pilot phase. The outlines are intended to serve as an aide to other instructional designers and faculty in community college programs across the nation.

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Included on the following pages are the Course Syllabi for each of the courses which were taught during the pilot program.

***M*achine Tool *A*dvanced *S*kills**
***T*echnology Program**

# MAST

# COURSE SYLLABUS

# BASIC PRINCIPLES OF MACHINE TECHNOLOGY

# MAST PROGRAM
## COURSE SYLLABUS
## BASIC PRINCIPLES OF MACHINE TECHNOLOGY

**Lecture hours/week: 3** **Lab hours/week: 3** **Credit hours: 4**

**COURSE DESCRIPTION:**

This course offers the basic principles required in the Machine Technology field relative to measurements, common formulas, machining applications, safety, and interpretation of basic drawings. (FT) Associate Degree Credit.

**PREREQUISITES:** **NONE**

**COURSE OBJECTIVES**

Students who have successfully completed this course will be able to:

1. Identify and demonstrate a thorough understand of common machine safety practices.
2. Identify common measuring instruments and their accessories.
3. Demonstrate proper use of common measuring instruments and their accessories.
4. Demonstrate proper care of common measuring instruments and their accessories.
5. Identify commonly used mathematical formulas used in the machining environment.
6. Demonstrate proper use of mathematical formulas used in the machining environment.
7. Use mathematical calculations and reference tables to determine typical numerical results needed in machining.
8. Identify common cutting tools and their accessories.
9. Demonstrate proper use and care of common cutting tools and their accessories.
10. Demonstrate reading and writing skills to read and prepare required documents for course work.
11. Demonstrate communication skills to interact successfully with members of working teams and instructor.

**REQUIRED COURSE MATERIALS:**

**Textbooks:** Examples of appropriate textbooks include:
**Technology of Machine Tools**, 4th Edition, 1990.
**Blue Print Reading For Industry**, 1986.
**Machinery's Handbook** , Industrial Press

**Hand Tools/Supplies:** Examples of appropriate hand tools and supplies include:
Scientific Calculator
6 ruler

## METHOD OF INSTRUCTION:

**Lecture:** Presentations will include: lecture with or without, various audio-visual aids; discussion, debate, and/or critique; demonstrations; computer assisted or other self-paced instruction; field trips or field assignments; laboratory assignments utilizing specifically planned instructional activities or "live" work.

**Laboratory:** Laboratory will be a "hands-on" process.

**Method of Evaluation:** A student's grade will be based on multiple measures of performance. The assessment will measure development of independent critical thinking skills and will include evaluation of the student's ability to:

1. perform the manipulative skills of the craft as required to satisfactorily complete laboratory assignments
2. apply theory to laboratory assignments
3. satisfactorily perform on written, oral, or practical examinations
4. satisfactorily perform on outside assignments including writing assignments/processing documents
5. contribute to class discussions
6. maintain attendance per current policy
7. follow all laboratory rules and safety regulations

## COURSE OBJECTIVES: TECHNICAL COMPETENCIES

After the successful completion of this course the student will be able to:

**A. DEMONSTRATE SAFETY PRACTICES IN MACHINING ENVIRONMENT**

1. Use Proper Safety Equipment
   a. Identify safety equipment used in the machine environment
   b. State effects of proper and improper safety equipment
   c. Demonstrate proper use of common safety equipment
2. Identify Proper Clothing
   a. Demonstrate proper dress for machining environment
   b. State improper dress and its effects
3. State Proper Attitudes for Safety
   a. Explain responsibility for oneself and others
   b. State benefits of correct safety practices
   c. Explain cost of poor safety practices
4. Handle Chemicals Properly
   a. Interpret material safety data sheets "MSDS"
   b. Describe proper storage and disposal of chemicals
   c. Identify labeling used for chemicals
   d. Explain special precautions for handling chemicals
   e. Discuss OSHA's and E.P.A.'s impact on chemical handling
5. Identify Fire Hazards in Machining
   a. Identify fire hazards in machining environment and how to eliminate
   b. Identify classes of fire extinguishers

c. State methods of dealing with fires

6. Demonstrate Proper Personal Hygiene
   a. Identify hygiene as a part of personal safety
   b. State effect of oils, solvents, and coolants on the skin and eyes
   c. Exhibit proper personal hygiene
7. Demonstrate Proper Laboratory Cleaning
   a. Discuss the effects of a filthy work environment
   b. State impact of unclean work area on safety, machine tool accuracy and machine tool fixtures.
   c. Exhibit proper cleaning of machine tools and accessories

**B. USE MEASURING INSTRUMENTS AND THEIR ACCESSORIES**

1. Identify Applications and Limitations of Measuring Instruments
   a. Identify common measuring instruments and their applications
   b. Identify limitations of each measuring instrument
   c. Explain and demonstrate methods of measuring instrument calibration
   d. Demonstrate proper handling of measuring instruments.
2. Demonstrate Use of Measuring Instruments
   a. Rulers (scales)
   b. Outside micrometers
   c. Vernier calipers
   d. Dial calipers
   e. Depth micrometers
   f. Inside micrometers
   g. Telescoping gauges
   h. Edge finders
      (1) Test and dial indicators
      (2) Gauge blocks
      (3) Coordinate Measuring Machine (CMM)
   i. Height gauges
   j. Protractors
   k. Bore gauges

**C. DEMONSTRATE USE OF MATHEMATICAL FORMULAS IN MACHINING**

1. Perform Mathematical Computations with Calculator
   a. Explain need of using mathematics in machining
   b. Explain the benefits of a scientific pocket calculator
   c. Demonstrate ability to add, subtract, multiply and divide whole numbers
2. Calculate Fractions and Decimals with Calculator
   a. Demonstrate the ability to add, subtract, multiply and divide fractions
   b. Demonstrate the ability to convert fractions to decimals
   c. Demonstrate the ability to add, subtract, multiply and divide decimals
   d. Demonstrate the ability to round off numbers and state limitations
   e. Demonstrate the ability to convert decimals to base fractions
3. Convert Metric and US Standard Units of Measure
   a. Explain use of metric system
   b. Convert U.S. system units to metric system units
   c. Convert metric system units to U.S. system units
4. Perform RPM Calculations

a. Explain the need to properly calculate RPM's
b. Describe implications of changing variables in formulas
c. Explain effect of different alloys and cutting tools on RPM's
d. Demonstrate correct use of formulas to achieve proper RPM

5. Perform Feed Calculations
   a. State the need for proper feed calculations
   b. Explain meaning of each variable in feed equations
   c. Explain position and negative effects of RPM, feed, and depth of cut on tool life, production and profitability
   d. List benefits of increased production related to increased profit
   e. State differences between inch per revolution (IPR) and inch per minute (IPM)
   f. State proper application of IPR and IPM.
   g. Explain chip load per tooth for roughing verses finishing of different materials
   h. Explain effects of set-up rigidly, tool diameter, length and horsepower on feed
   i. Explain step over distances involved in milling
   j. Establish proper roughing and finishing feed rates for:
      (1) Face milling
      (2) Slot milling
      (3) Drilling
      (4) Reaming
      (5) Tapping
      (6) Turning
      (7) Boring
      (8) Single point turning
      (9) Reaming
      (10) Facing
6. Perform Depth of Cut Calculations
   a. State depth of cut calculations
   b. Demonstrate ability to calculate RPM, feed and depth of cut
7. Perform Thread Cutting Calculations
   a. State uses of thread calculations
   b. Describe equations to identify thread depth and measure thread sizes
   c. Demonstrate proper use of thread calculations
8. Perform Tap Drill Calculations
   a. State uses of tap drill calculations
   b. Explain tap size verses drill sizes
   c. Describe equation to calculate tap drill sizes for fractional taps
   d. List equation converting tap size number to decimal
   e. Demonstrate use of tap drill calculations
9. Interpret Reference Tables Related to Machining
   a. Identify commonly used reference tables
   b. Locate specific reference tables in various support documentation
   c. Extract and apply reference information

**D. APPLY TRIGONOMETRIC CALCULATIONS IN MACHINE TECHNOLOGY**

1. Apply Cartesian Coordinate System in Machining
   a. Explain Cartesian Coordinate system
   b. Explain + and - number lines and use to represent Cartesian Coordinate System
   c. Explain use of Cartesian Coordinate system in machining
   d. Explain different quadrants & their values of x, y, & z
   e. Show location of rectangular coordinates and axes
   f. Explain integration of polar coordinates onto the rectangular coordinate system and the degree value of each quadrant
   g. Place specific x, y and z locations on the Cartesian Coordinate system
   h. Explain placement of rotational degrees on coordinate system
   i. Place various angular locations on coordinate system
2. Perform Trigonometric Calculations
   a. Explain the need for calculating length and angles in CAD/CAM and CNC Programming
   b. Explain degrees, minutes and seconds of angles
   c. Explain decimal representation for angles
   d. Convert degrees, minutes and seconds to decimal format using calculator
   e. Convert decimal format to degrees, minutes and seconds using calculator
   f. State and explain equations for finding angles and sides
      (1) Sine of Angle = Opposite Side / Hypotenuse
      (2) Cosine of Angle = Adjacent Side / Hypotenuse
      (3) Tangent of Angle = Opposite Side / Adjacent Side
   g. Convert sine, cosine and tangent to angle using natural trigonometric tables and calculator
   h. Convert angle to sine, cosine and tangent using natural trigonometric tables and calculator
3. Perform Pythagorean Theorem Calculations
   a. Explain Pythagorean Theorem strengths and limitations
   b. List and explain the equations for the Pythagorean Theorem:
   c. Demonstrate use of Pythagorean equations to find sides of triangles
   d. Combine sine, cosine, and tangent equations with Pythagorean equations to solve missing sides and angles
   e. Demonstrate use of combined methods to solve missing lengths and angles
4. Perform Polar Trigonometry Calculations
   a. Explain trigonometry using polar coordinates
   b. Explain sine = opposite side / hypotenuse and cosine = adjacent side / hypotenuse relative to polar trigonometry
   c. Explain comparison and application of sine bar and sine function
   d. Apply benefits of not being limited to 90°
   e. Describe calculator equation using "Casio" type scientific calculations
   f. Describe time benefit to using Polar coordinates to calculate locations
   g. Demonstrate proper use of Polar trigonometry to calculate locations on a bolt hole circle
   h. Explain translation of center reference relative to a known point to give absolute location of new coordinates to a X , Y reference used in CNC Programming

i. Demonstrate the ability to translate locations from a center reference position to a absolute position

**E. DEMONSTRATE CUTTING TOOL IDENTIFICATION AND APPLICATION**

1. Identify Cutting Tools and Describe Tool Nomenclature
   a. Identify different types of end mills, center drills, drills, reamers, taps
   b. Explain cost differences for types of tooling within same tool classification, including:
      (1) End mills
      (2) Face mills
      (3) Center drills
      (4) Drills
      (5) Reamers
      (6) Single point boring head
      (7) Single point threading tools
      (8) Counter boring tools
      (9) Spot facing tools
      (10) Taps
2. Identify and Explain Application of Machine Tools
   a. List different applications requiring proper selections of each tool
   b. Identify proper cutting tool for specified application
   c. Demonstrate ability to identify cutting tools defined by blueprint, process documentation and verbal instruction
   d. Demonstrate ability to give written or verbal justification of tool selection to include cost differential

**F. IDENTIFY AND DESCRIBE MACHINE OPERATION NOMENCLATURE**

1. Identify and Describe Types of Milling
   a. Explain climb milling
   b. Explain conventional milling
   c. Describe benefits and draw backs of each application
   d. Explain contouring operations
   e. Explain pocketing operations
2. Describe Drilling/Boring Operations and Their Applications
   a. Describe applications for center drilling
   b. List and explain the different accuracies achieved from drilling, reaming and single point boring
   c. List and explain reasons to use single point boring
   d. Describe the difference between spot facing and counter boring operations
3. Identify and Describe Threading Operations
   a. Identify and describe common single point threading tool set-ups
   b. Describe the reasons for choosing single point threading tools instead of taps and dies
   c. Identify and describe various taping operations and accessories

**G. APPLY ELEMENTS OF BLUEPRINT READING TO MACHINING TECHNOLOGY**

1. Describe Types of Blueprint Drawings
   a. Describe and create common line types used in engineering drawings.
   b. Identify and describe reasons for the following drawing types:

(1) Orthographic projections
(2) Pictorial drawings
(3) Detail drawings
(4) Sectional views
(5) Assembly drawings

2. Describe Blueprint Dimensions
   a. Identify types of dimensions found on blueprints
   b. Interpret, describe and create dimensions as found on blueprints
   c. Interpret, describe and create tolerances found on blueprints
   d. Explain effects of tolerances on machining operations and cost
   e. Identify and interpret geometric dimensioning and tolerancing symbols.
3. Interpret Title, Notes, Revision and Material Information
   a. Identify and explain difference between general and local drawing notes
   b. Describe information contained in title blocks
   c. Locate and interpret various call outs in material listings
4. Interpret Blueprint Drawings
   a. Identify various surface finish symbols
   b. Interpret and discuss various call outs of a surface finish symbol
   c. Identify need for various process documentation
   d. Interpret and create process documentation, including:
      (1) Planning documentation
      (2) Inspection documentation
      (3) Engineering changes
      (4) Set-up documentation

## COURSE OBJECTIVES: SCANS COMPETENCIES

*The Secretary's Commission on Achieving Necessary Skills (SCANS), U.S. Department of Labor, has identified in its "AMERICA 2000 REPORT" that all students should develop a new set of competencies and foundation skills if they are to enjoy a productive, full and satisfying life. These are in addition to the Technical Workplace Competencies required by industry. SCANS is made up of five competencies and a three-part foundation of skills and personal qualities that are needed for solid job performance.*

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The following activities will be performed by each student for successful completion of this course:

**I. COMPETENCIES**

*A. Resources: Identifies, organizes, plans, and allocates resources*

1. follow a schedule to complete assigned tasks on time
2. determine initial cost of materials and "value added" as a result of machining
3. complete a stock request form for required material
4. provide a self-evaluation of performance based on the time and quality of work

*B.* ***Interpersonal:*** *Works with others*

1. complete assigned responsibilities within the shop floor serving as a member of the team
2. provide individual assistance/direction to peers as requested
3. produce machine parts to acceptable levels of quality as required
4. work well with all members of you class

*C.* ***Information:*** *Acquired and uses information*

1. read and interpret blueprints
2. organize and practically apply theories of machine tool operation
3. perform basic semi-precision and precision layout as necessary

*D.* ***Systems:*** *Understands complex inter-relationships*

1. demonstrate knowledge of the following systems:
   a. laboratory organization structure: physical and social
   b. organization of personnel and facilities on the shop floor
   c. systematic approach to the metal removal process
   d. dimensioning and measurement systems
   e. systematic organization of training materials
2. monitors and corrects performance during
   a. the machining process
   b. adjustments of individual laboratory work schedule
   c. constantly evaluating the quality of work to achieve acceptable standards
   d. maintains record of evaluations and sets individual goals

*E.* ***Technology:*** *Works with a variety of technologies*

1. chooses procedure, tools and equipment required to produce a part
2. applies appropriate procedures and uses appropriate tools and equipment to produce a machined part to acceptable standards
3. maintains and troubleshoots equipment
   a. applies appropriate preventative maintenance
   b. when operating machines
   c. reports all malfunctions of equipment to supervisor/instructor
   d. perform clean-up assignments of machine and shop floor at the end of the laboratory

## II. FOUNDATION SKILLS

*A.* ***Basic Skills:*** *Reads, writes, performs arithmetic and mathematical operations, listens and speaks.*

*1.* ***Reading:*** *Locates, understands, and interprets written information in pose and in documents such as manuals, graphs, and schedules*
   a. studies student laboratory manual
   b. interprets blueprints and technical drawings
   c. read/studies textbook
   d. follow a daily laboratory schedule to maintain appropriate time-line and product completion

*2.* ***Writing:*** *Communicates thoughts, ideas, information, and messages in writing; and creates documents such as letters, directions, manuals, reports, graphs, and flow charts*

a. outline the steps necessary to produce a simple machine part
b. maintain a lecture notebook
c. submit written responses to chapter question assignments
d. complete all written assignments

3. ***Arithmetic\Mathematics:*** *Perform basic computations and approaches practical problems by choosing appropriately from a variety of mathematical techniques.*
   a. determines optimum machining speeds, feeds, and depth of cut
   b. calculates "value added to the part"
   c. aligns machine and/or work holding device
   d. taps and threads
   e. keeps a running computation of individual grade
   f. intraconverts fractions to decimal expressions
   g. use protractors to lay-out angle machining
   h. use trigonometry to solve angle and taper calculations
4. ***Listening:*** *Receives, attends to, interprets, and responds to verbal messages and other cues*
   a. assimilate classroom instruction
   b. interpret and assimilate video instruction
   c. observe laboratory demonstrations
   d. seek and receive individualized instruction in the laboratory
5. ***Speaking:*** *Organizes ideas and communicates orally*
   a. participates in classroom discussions
   b. organize ideas and communicate specific questions to the instructor
   c. verbally affirms understanding of a concept, procedure, or required skill
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B. ***Thinking Skills:*** *Thinks creatively, makes decisions, solves problems, visualizes, knows how to learn and reasons.*

1. ***Decision Making:*** *Specifies goals and constraints, generates alternatives, considers risks, and evaluates and chooses best alternative*
   a. identifies personal goals
   b. identifies actions required to accomplish personal goals
2. ***Problem Solving:*** *Recognizes problems and devises and implements plan of action*
   a. makes daily accommodations to stay on schedule
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   c. balances social and academic life/responsibilities
   d. accepts responsibility
3. ***Seeing Things In the Mind's Eye:*** *Organizes, and processes symbols, pictures, graphs, objects, and other information*
   a. interprets technical drawings
   b. interprets technical illustrations and symbols
   c. understands both written and verbal instructions
   d. assimilates process during instructor demonstrations

4. ***Knowing How to Learn:*** *Use efficient learning techniques to acquire and apply new knowledge and skills*
    a. demonstrate mastery of the basic skills and techniques
    b. use these sequential skills to support mastery of new skills
    c. understand the sequential nature of acquired skills and the subsequent knowledge application of new skills and techniques
5. ***Reasoning:*** *Discovers a rule or principle underlying the relationship between two or more objects and applies it when solving a problem.*
    a. understands that practice may not make it perfect but it certainly will improve the skill of the operator
    b. understands that the quality of the product is a function of the time of the operation and the attitude and skill of the machinist
    c. understands the relationship between different metals and the tool applied to the metal surface and adjusts machining parameters accordingly.

C. ***Personal Qualities:*** *Displays responsibility, self-esteem, sociability, self-management, and integrity and honesty.*
1. ***Responsibility:*** *Exerts a high level of effort and perseveres towards goal attainment*
    a. develops an understanding that in order to be successful you must be a "good" student
    b. develops an understanding that a "good" student is the one who is prompt to every class and has prepared for the day's work
    c. develops an understanding good students know what they are going to do in class and does not waste time
    d. develops a fine work-ethic
2. ***Self-Esteem:*** *Believes in own self-worth and maintains a positive view of self*
    a. learns to take pride in his or her work through positive reinforcement
    b. sees himself or herself as an asset to the class through continued contributions to the group and a shared common goal
    c. understands that an individual with a positive attitude and the belief in their own abilities will systematically seek solutions and be a valuable employee
3. ***Sociability:*** *Demonstrates understanding, friendliness, adaptability, empathy, and politeness in group settings*
    a. assist classmates in improving technical skills
    b. assist students with special needs as a peer mentor
    c. share laboratory resources (machines, tools, and instructor's individual attention)
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    b. maintain a record of academic achievement (individual grade book)
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d. accept the responsibility for self-management

5. ***Integrity/Honesty:*** *Chooses ethical courses of action*
   a. accept the responsibility for own actions
   b. exhibit personal honesty at all times
   c. accept the challenge of doing your own work in the laboratory, during examination, and on outside assignments
   d. understand the consequences of unethical behaviors

MACT140
05\081596

# MAST PROGRAM
## COURSE SYLLABUS
## INTRODUCTION TO CNC AND EDM

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**Lecture hours/week: 3** **Lab hours/week: 3** **Credit hours: 4**

**COURSE DESCRIPTION:**

Theory of advanced machining techniques including numerically controlled mills and lathes and Electro-Discharge machining. Emphasis on introduction to CNC programming using "G" & "M" codes. Students in this class are expected to have previous machine laboratory experience or concurrent enrollment. (FT) Transfer Credit: CSU.

**PREREQUISITES:** Concurrent enrollment, or completion with "C" or above, in Basic Principles of Machine Technology.

**COURSE OBJECTIVES:**

Students successfully completing this course will be able to:

1. Identify CNC Mills and Lathes, their controls and accessories.
2. Identify EDM machines, their controls and accessories.
3. Use charts, reference tables, math calculations to determine speeds and feeds.
4. Demonstrate the programming of CNC machines.
5. Use EDM processes for machining components.
6. Demonstrate proper use of personal computers.
7. Demonstrate a basic understanding of the common DOS and windows commands as used on personal computers to create various programs.
8. Demonstrate reading and writing skills to read and prepare required documents for course work.
9. Demonstrate communication skills to interact successfully with members of working teams and instructor.

**REQUIRED COURSE MATERIALS:**

**Textbooks:** Examples of appropriate textbooks include:
Technology of Machine Tools, 4th Edition, 1989.
Fundamentals of Numerical Control, 1990.
Computer Numerical Control: From Programming to Networking, 1994.
Anilam Vertical Machining Program Manual, 1991.
Bendix Dynapath Manual, 1989.
Hansvedt Manual, 1988.
Fadal Programming Manual, 1991.
Bridgeport Programming Manual, 1980.

**Fanuc6T Programming Manual**, 1988.
**Anilam Lathemate Program Manual**, 1994.

**Hand Tools/Supplies:** Examples of appropriate hand tools and supplies include:
6" ruler
Scientific Calculator
Specified small end mills
Computer Diskettes

## METHOD OF INSTRUCTION:

**Lecture:** Presentations will include:

1. Lecture with, or without, various audio-visual aids
2. Discussion, debate, and/or critique
3. Demonstration
4. Computer-assisted or other self-paced instruction
5. Field trips or field assignments
6. Laboratory assignments utilizing specifically planned instructional activities or "live" work

**Laboratory:** Laboratory will be a "hands-on" process

**Writing Assignments:** Writing assignments include:

1. Completing assigned reports
2. Providing written answers to assigned questions
3. Performing arithmetic calculations as assigned
4. Maintaining a notebook of class assignments and activities
5. Completing a 500 word written report dealing with a subject related to this course

**Appropriate Outside Assignments:** Students are expected to spend a minimum of two hours outside of class in practice and preparation for each hour of theory in class. Appropriate assignments include:

1. Researching appropriate readings
2. Preparing research reports
3. Preparing writing assignments
4. Studying as needed to perform successfully in class

**Appropriate Assignments That Demonstrate Critical Thinking:**

1. Students will be required to demonstrate machining a work piece using their own program.
2. Students must estimate machining time involved in producing a programmed work piece.
3. Students will interpret blueprints to produce required machine parts to specifications in the time allowed.
4. Students will be required to demonstrate using the basic DOS and Windows commands of a personal computer.

**Method of Evaluation:** A student's grade will be based on multiple measures of performance. The assessment will measure development of independent critical thinking skills and will include evaluation of the student's ability to:

1. perform the manipulative skills of the craft as required to satisfactorily complete laboratory assignments
2. apply theory to laboratory assignments
3. satisfactorily perform on written, oral, or practical examinations
4. satisfactorily perform on outside assignments including writing assignments
5. contribute to class discussions
6. maintain attendance per current policy
7. follow all laboratory rules and safety regulations

**LECTURE OUTLINE:**

| Lecture Topics | Text Reference Page | Contact Hrs. |
|---|---|---|
| **CNC Machines** | | |
| A. Mills | | |
| B. Lathes | | |
| C. Machining Centers | | |
| D. Grinders | | |
| **Electro-Discharge Machines** | | |
| A. Theory of Operation | | |
| B. Rigid Electrode | | |
| C. Wire Electrode | | |
| **Controls** | | |
| A. Mini-computers | | |
| B. Desk Top P.C.S. | | |
| C. Anilam Control | | |
| D. Fadal Control | | |
| E. Fanuc Control | | |
| **Personal Computers** | | |
| A. Basic Terminology | | |
| B. Basic Operation | | |
| C. Basic DOS Commands | | |
| **Programming** | | |
| A. Mills | | |
| B. Lathes | | |
| | **Total Lecture Hours** | — |

**LAB OUTLINE:**

| Lab Topics | Contact Hrs. |
|---|---|
| **CNC Machines** | |
| A. Mills | |
| B. Lathes | |
| C. Machining Centers | |
| D. Grinders | |
| **Electro-Discharge Machines** | |

A. Theory of Operation
B. Rigid Electrode
C. Wire Electrode

**Controls**

A. Mini-computers
B. Desk Top P.C.S.
C. Anilam Control
D. Fadal Control
E. Fanuc Control

**Personal Computers**

A. Basic Terminology
B. Basic Operation
C. Basic DOS Commands

**Programming**

A. Mills
B. Lathes

**Total Lab Hours** —

## COURSE OBJECTIVES: TECHNICAL COMPETENCIES

After the successful completion of this course the student will be able to:

**A. IDENTIFY AND DESCRIBE ESSENTIALS AND SAFETY OF CNC SYSTEMS**

1. Identify and Explain Essentials
   a. Define numerical control
   b. Explain history and future of CNC technology
   c. Identify basic elements of CNC system
   d. Define Computer Numerical Control (CNC)
   e. Explain advantages and limitations of CNC
   f. Identify applications of CNC technology
2. Compare Types of CNC Systems
   a. Identify and describe modes on numerical control systems
   b. Explain difference between the following:
      (1) Point-to-Point
      (2) Axial Path
      (3) 45° Line Type
      (4) Linear Path
      (5) Continuous Path
   c. Describe CNC interpolation
   d. Identify types of CNC interpolations
   e. Explain difference between open loop and closed loop systems
   f. List benefits and problems of open and closed loop systems
3. Demonstrate Safety Practices Related to CNC Systems
   a. Demonstrate safety practices, including:
      (1) Safety guard/door interlocks
      (2) Power box interlocks
      (3) Tool loading and unloading
      (4) Loading and unloading work holding devices

(5) Machine coolant disposal

b. Describe/identify personal safety equipment

**B. IDENTIFY AND DESCRIBE TYPES OF CNC HARDWARE AND SOFTWARE**

1. Identify and Describe CNC Hardware
   a. Compare NC and CNC systems
   b. Identify components of CNC machine control unit (MCU)
   c. Define applications of operator control panel
   d. Explain functions of operator control panel
   e. Define utilities found on typical control panel
   f. Select appropriate CNC controls
2. Describe CNC Software
   a. Describe software related to machine tool
   b. Describe applications of operation, interface and application software
   c. Describe interface of software and hardware
3. Explain Feed Back Drive System
   a. Describe feed drive system
   b. Explain feed back mechanisms
   c. Compare direct and indirect measurement systems

**C. IDENTIFY AND DESCRIBE MACHINE AXES AND COORDINATE SYSTEMS**

1. Identify and Describe Machine Axes
   a. Define and identify machine axes X, Y and Z
   b. Identify and describe linear axes using right hand rule
   c. Identify and define primary rotary axes a, b and c
2. Describe Coordinate Systems
   a. Describe Cartesian Coordinate system as used in NC Program
   b. Define relationship of Cartesian Coordinate system with machine axes.
3. Define Characteristics of Positioning Systems
   a. Define application of absolute positioning systems
   b. Define application of incremental positioning systems
4. Define Reference Systems
   a. Describe characteristics of:
      (1) Machine reference coordinates
      (2) Work reference coordinates
      (3) Program reference coordinates
      (4) Fixtures offset coordinates

**D. DESCRIBE AND INTERPRET CNC CODING SYSTEMS**

1. Interpret Number Bases
   a. Interpret decimal and binary bases
   b. Interpret octal and hexadecimal bases
2. Describe NC Program Storage Media
   a. Describe the media
   b. Describe advantages and disadvantages of each media
3. Describe EIA and ASCII Formatted Tapes
   a. Describe EIA format on tapes
   b. Describe ASCII format on tapes
   c. Describe differences in EIA and ASCII formats

**E. WRITE NC PROGRAMS**

1. Create NC Words

a. Define NC characters, blocks and words
b. Identify and describe commonly used NC codes
c. Describe and create safe start blocks
d. Combine NC codes to create part program

2. Create NC Programs
   a. Use absolute (G90) and incremental (G91) positioning
   b. Use rapid positioning (G00) and linear interpolation (G01)
   c. Use circular interpolation (G02) and (G03)
   d. Identify plane selections (G17, G18, G19)
   e. Apply proper plane selection to circular interpolation
   f. Define and describe axis modifiers (I, J, K) and apply to circular interpolation
3. Calculate and Program Cutter Speed
   a. Describe cutter compensation commands (G40, G41, G42)
   b. Describe relationships associated with G41 and climb milling
   c. Describe relationship associated with G42 and conventional milling
   d. Evaluate reference documentation to establish machinability factors for RPM equation.
   e. Apply RPM calculations to identify proper spindle speed "S" word
4. Calculate and Program Cutter Feed and Depth of Cut
   a. Evaluate reference documentation to establish feed rate factors
   b. Apply depth of cut calculations for programming efficiency
   c. Apply feed equation to establish correct feed "F" word
5. Program Tool Selection
   a. Describe and apply unit input code (G70 and G71) correctly
   b. Describe tool function "T" word and its use
   c. Describe retract quill to Z machine home "M6"
   d. Describe and apply "T" word with "M6" to create tool change
   e. Apply "M" codes to program
   f. Describe and list common "M" words and their applications
   g. Describe "M00" program stop and "M01" optional stop applications
   h. Describe "M02" end of program and "M30" end of tape
6. Program Spindle Operation
   a. Identify spindle commands
   b. Describe "M03" spindle on clockwise and "M04" spindle on counter clockwise
   c. Describe "M05" stop spindle
   d. Identify and describe coolant commands "M07", "M08" and "M09"
   e. Apply "M" codes to program
7. Program Fixed Cycles
   a. Identify and describe fixed cycles "G81 - G89"
   b. Describe benefits and time saving by using fixed cycles in programming
   c. Explain different fixed cycle formats for different controllers
   d. Apply fixed cycles to programs
8. Program Operator Messages
   a. Identify and describe non-machine code "operator messages"
   b. Describe symbols to isolate operator messages from program "*" "( )"
   c. Apply operator messages to NC part program as needed

F. **PLAN PROCESS FOR NC OPERATIONS**

1. Plan for Raw Material Preparation
    a. Describe effect of material preparation on production
    b. Describe typical shapes of raw materials
    c. Describe effects of proper material preparation
    d. Describe ways to minimize wasted time and material
    e. Describe pre-machining of materials to avoid excessive CNC machine time
    f. Create material preparation plan for NC machining
2. Plan Use of Machining Fixtures
    a. Describe and identify various work holding devices
    b. Describe clamping principles and cautions
    c. Describe work piece locating principles
    d. Create plan for work holding devices and tooling selection on program planning sheet.
    e. List common types of tool alloys
    f. Identify advantages and disadvantages of different alloys
    g. Evaluate prices for various alloys compared to productivity changes
    h. Select tooling based on various budget models
    i. Create tool planning list showing various models

G. **DEMONSTRATE USE OF ELECTRONIC DISCHARGE MACHINE (EDM)**

1. Describe EDM Applications
    a. Describe history and theory of EDM
    b. Interpret feed charts designed for wire EDM
    c. Create samples of feed setting for wire EDM
    d. Discuss methods of programming wire EDM
    e. Compare program code to CNC machining center
    f. Create sample program for wire EDM
2. Describe Use of Sinker or "Ram" Type EDM
    a. Identify and describe parts of machine
    b. Describe various applications suited for RAM type EDM
    c. Describe reasons for choosing EDM over traditional machining
    d. Describe and list materials used for "cutting tools" electrodes
    e. Describe dielectric material and their application
3. Program Sinker or "Ram" Type EDM
    a. Identify and describe power supply and various settings
    b. Describe power and feed setting effects on production time, surface finish and life of electrode
    c. Identify and apply work holding devices
    d. Mount electrode in machine tool
    e. Locate work piece in correct position
    f. Set stops for proper depth
    g. Adjust power and feed setting
4. Demonstrate Safety Practices Related to EDM Machining
    a. Demonstrate operating safety practices
    b. Describe/Identify personal safety equipment
5. Machine Work with EDM
    a. Machine project to specifications
    b. Inspect project

c. Turn off machine
d. Dismount project

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   b. assist students with special needs as a peer mentor
   c. share laboratory resources (machines, tools and instructor's individual attention)

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   a. perform in-process quality checks on machined parts
   b. maintain a record of academic achievement (individual grade book)
   c. make accommodations to laboratory schedules due to broken machines/tools
   d. accept the responsibility for self-management

5. ***Integrity/Honesty:*** *Chooses ethical courses of action*
   a. accept the responsibility for own actions
   b. exhibit personal honesty at all times
   c. accept the challenge of doing your own work in the laboratory, during examination, and on outside assignments
   d. understand the consequences of unethical behaviors

*M*achine Tool *A*dvanced *S*kills
*T*echnology Program

MAST

# COURSE SYLLABUS

# INTRODUCTION TO CNC VERIFICATION AND COMMUNICATION

# MAST PROGRAM
## COURSE SYLLABUS
## INTRODUCTION TO
## CNC VERIFICATION AND COMMUNICATION

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**Lecture hours/week: 3** **Lab hours/week: 3** **Credit hours: 4**

**COURSE DESCRIPTION:**

Theory and application of verification and communication of CNC programs. (FT) Transfer Credit: CSU.

**PREREQUISITES:** **Concurrent enrollment, or completion with "C" or above, in Introduction to CNC and EDM**

**COURSE OBJECTIVES:**

Students who have successfully completed this course will be able to:

1. Identify various methods of verifying CNC programs.
2. Identify various methods of communicating with CNC machines.
3. Demonstrate proper use of personal computers.
4. Demonstrate a basic understanding of the common DOS and Windows commands as used on personal computers to create various programs.
5. Demonstrate reading and writing skills to read and prepare required documents for course work.
6. Demonstrate communication skills to interact successfully with members of working teams and instructor.

**REQUIRED COURSE MATERIALS:**

**Textbooks**: Example of appropriate textbooks include:
Technology of Machine Tools, 4th Edition, McGraw Hill, 1989
Vericut Programming Manual, 1992
N-See Programming Manual, 1992
MasterCam For Windows Programming Manual, 1992
Computer Numerical Control: From Programming to Networking, Reston Publishing Company, 1991
SmartCam Programming Manual, 1992
Anilam Program Manual, 1991
Bendix Dynapath Manual, 1989
Fadal Programming Manual, 1992
Fanuc 6T Programming Manual, 1988
Greco System Manual, 1992

**Hand Tools/Supplies:** Examples of appropriate supplies include:
Computer Diskettes
Calculator

## METHOD OF INSTRUCTION:

**Lecture:** Presentations will include:

1. Lecture with, or without, various audio-visual aids
2. Discussion, debate, and/or critique
3. Demonstration
4. Computer-assisted or other self-paced instruction
5. Field trips or field assignments
6. Laboratory assignments utilizing specifically planned instructional activities or "live" work

**Laboratory:** Laboratory will be a "hands-on" process.

**Writing Assignments:** Writing assignments include:

1. Completing assigned reports
2. Providing written answers to assigned questions
3. Performing arithmetic calculations as assigned
4. Maintaining a notebook of class assignments and activities
5. Completing a 500 word written report dealing with a subject related to this course

**Appropriate Outside Assignments**: Students are expected to spend a minimum of two hours outside of class in practice and preparation for each hour of theory in class. Appropriate assignments include:

1. Researching appropriate readings
2. Preparing research reports
3. Preparing writing assignments
4. Studying as needed to perform successfully in class

**Appropriate Assignments That Demonstrate Critical Thinking:**

1. Students will be required to demonstrate verification and communication of their own programs.
2. Students must estimate machining time involved in producing a programmed work piece.
3. Students will interpret blueprints to produce required machine parts to specifications in the time allowed.
4. Students will be required to demonstrate using the basic DOS and Windows commands of a personal computer.
5. Students will be required to verify and communicate supplied programs, and make corrections and recommendations for efficiency and safety.

**Method of Evaluation:** A student's grade will be based on multiple measures of performance. The assessment will measure development of independent critical thinking skills and will include evaluation of the student's ability to:

1. perform the manipulative skills of the craft as required to satisfactorily complete laboratory assignments
2. apply theory to laboratory assignments
3. satisfactorily perform on written, oral, or practical examinations/processing documents
4. satisfactorily perform on outside assignments including writing assignments
5. contribute to class discussions
6. maintain attendance per current policy
7. follow all laboratory rules and safety regulations

**LECTURE OUTLINE:**

| Lecture Topics | Text Reference Page | Contact Hrs. |
|---|---|---|
| **CNC Verification** | | |
| A. Graphing | | |
| B. Solid Modeling Verification Software | | |
| C. Shaded Model Verification Software | | |
| D. Back-Plotting | | |
| E. Graphics on Controller | | |
| **CNC Communications** | | |
| A. Theory of Communication | | |
| B. RS-232 Interface | | |
| C. Tape Loading | | |
| D. Downloading | | |
| E. Uploading | | |
| F. Handshaking | | |
| G. Communication using CAM Software | | |
| H. Greco System's Communication | | |
| **Controls** | | |
| A. Fadal Controller | | |
| B. Desk Top P.C.S. | | |
| C. Anilam Control | | |
| D. Fanuc Control | | |
| E. Dynapath System 10 | | |
| **Personal Computers** | | |
| A. Basic Terminology | | |
| B. Basic Operation | | |
| C. Basic DOS Commands | | |
| | **Total Lecture Hours** | — |

**LAB OUTLINE:**

| Lab Topics | Contact Hrs. |
|---|---|
| **CNC Verification** | |
| A. Graphing | |
| B. Solid Modeling Verification Software | |

C. Shaded Model Verification Software
D. Back-Plotting
E. Graphics on Controller

**CNC Communications**

A. Theory of Communication
B. RS-232 Interface
C. Tape Loading
D. Downloading
E. Uploading
F. Handshaking
G. Communication using CAM Software
H. Greco System's Communication

**Controls**

A. Fadal Controller
B. Desk Top P.C.S.
C. Anilam Control
D. Fanuc Control
E. Dynapath System 10

**Personal Computers**

A. Basic Terminology
B. Basic Operation
C. Basic DOS Commands

**Total Lab Hours** —

## COURSE OBJECTIVES: TECHNICAL COMPETENCIES

After the successful completion of this course the student will be able to:

**A. DEMONSTRATE USE OF PERSONAL COMPUTER**

1. Demonstrate Use of Computer Hardware
   a. Describe and demonstrate the function and proper use of common computer components: Power switch, Turbo switch, Video monitor, Keyboard, Mouse, Hard drive, Floppy disk drive, Printer & Plotter
2. Describe Functions of Memory Types
   a. Read only memory "ROM"
   b. Random access memory "RAM"
   c. Hard disk
   d. Floppy disk: 5 1/4" DSDD, 5 1/4" DSHD, 3 ½" DSDD, 3 ½" DSHD
   e. CD-Rom's
   f. Tape backups
3. Describe Main Computer Components and Their Application:
   a. Motherboard
   b. Video card
   c. Processor
   d. Parallel ports
   e. Co-Processor
   f. Ram chips
   g. Serial ports

4. Demonstrate Ability to Connect Basic Computer Components
   a. Monitor
   b. Mouse
   c. Computer (Central Processing Unit)
   d. Keyboard
   e. Printer
5. Identify Computer Components for CAD/CAM
   a. Describe and generate a list for a computer to operate CAD/CAM
   b. Describe reasons for component choices

**B. DEMONSTRATE USE AND SAFETY OF COMPUTER OPERATING SYSTEMS**

1. Choose Appropriate Operating Systems
   a. Describe the following operating systems and their application:
      (1) Disk Operating System (DOS)
      (2) Microsoft Windows and Windows for workgroups
      (3) Microsoft Windows NT and Windows 95
      (4) IBM OS/2 & UNIX
   b. Describe the strength and weakness of the operating systems
2. Demonstrate Safety Practice Related to CNC Systems
   a. Demonstrate operating safety practices for CNC machines
      (1) Safety guards/door interlocks
      (2) Power box interlocks
      (3) Tool loading and unloading
      (4) Loading and unloading work holding devices
      (5) Machine coolant disposal
   b. Describe/Identify personal safety equipment

**C. DEMONSTRATE USE OF BASIC DOS COMMANDS**

1. Operate Disk Commands
   a. Format a floppy diskette
   b. Create boot disk (system disk)
   c. Change disk drives
2. Operate View Commands
   a. View file using Dir command and with pause (/p) and wide (/w) switches
   b. View directory using tree command
   c. View file using Dir command with:
      (1) Filename and wildcards in place of extensions
      (2) Extensions and wildcards in place of file names
      (3) Filename and extension
3. Create Subdirectories and Files
   a. Make subdirectory
   b. Identify and describe filename and extensions
   c. Create filename and extension using DOS editor
4. Modify, Move and Copy Files
   a. Modify existing file using DOS editor
   b. Explain path statements
   c. Copy file to another location using:
      (1) Filename and extension
      (2) Wildcards
      (3) Wildcards and extensions in place of filename

(4) Filename and wildcards in place of extensions

d. Delete or erase file using filename or extension

e. Move file using:

(1) Filename and extensions

(2) Wildcards

(3) Wildcard and extensions in place of filename

(4) Filename and wildcards in place of extensions

f. Copy file and directory using Xcopy command

g. Create backup diskette using Diskcopy command

h. Change file name using Rename command

i. Change disk name using Label command

j. Delete directory using Remove Directory command

k. Create and modify batch files

5. Set Computer Clock, Date and Time

a. Set computer clock using Time command

b. Set computer calendar using Date command

6. Perform Disk Maintenance

a. Optimize memory storage using Chkdsk /F and Defrag command

b. Evaluate memory using Chkdsk

c. Maintain memory disk using Scandisk command

d. Describe utility packages used for disk maintenance

**D. DEMONSTRATE USE OF WINDOWS AND WINDOWS NT COMMANDS**

1. Manipulate Program Icons

a. Start windows

b. Describe program icons

c. Maximize and minimize program icons

d. Describe and maximize main program group

2. Use File Manager Functions

a. Open File Manager

b. Change drive using drive buttons

c. Pull down file selection using mouse

d. Tag file groups using mouse and Select key

e. Tag various files using mouse and Ctrl key

3. Move, Copy and Change Files in File Menu

a. Move file using mouse to drag and drop

b. Copy file using mouse to drag and drop

c. Delete file using mouse

d. Change filename and extension using Rename command

e. Change properties of file including:

(1) Read only, Archive, System, Hidden

4. Maintain and Print Directories and Files

a. Start an application from File Manager using Run

b. Start an application from File Manager using double click mouse method

c. Print file using Print command

d. Connect files to applications using the Associate command

e. Create directories (Parent and Child) using Create Directories command

f. Search for "lost" files using search command, filename, extension and wildcard

5. Use Disk Menu Utilities
    a. Pull down Disk Menu using mouse
    b. Copy disk using Copy Disk command
    c. Change disk label using Label Disk command
    d. Format disk using Format command
    e. Create System Disk using format command
    f. Change drive using Select Drive command
6. Manipulate View Menu Commands
    a. View files by filename, extensions and wildcards
    b. Display files showing all file details and partial file details
    c. Sort files by name, type, size and date
7. Exit File Manager
    a. Exit file manager by double clicking control menu box with mouse
    b. Exit file manager by choosing exit from file menu selection

**E. DEMONSTRATE USE OF MACRO'S IN WINDOWS AND WINDOWS NT PROGRAMS**

1. Use Basic Windows Command MACRO's
    a. Get help using the help key (F1)
    b. Close current application window (Alt + F4)
    c. Close Program Manager and exit Windows Program (Alt + F4, Enter)
    d. Close the current document window (Ctrl + F4)
    e. Change a DOS application from full-screen view to window and back to full screen (Alt + Enter)
    f. From DOS application open Control menu in Windows Program (Alt + Space bar)
    g. Send copy of current full-screen view of DOS text to Clipboard (Print Screen)
    h. Send a copy of current window to Clipboard (Alt + Print Screen)
2. Switch Task using MACROS
    a. Bring up the Task List dialog box to display the list of the programs (Ctrl + Esc)
    b. Cycle through the list of active tasks (Alt + Tab)
    c. Cycle through open windows and minimized programs (Alt + Esc)
3. Use Menu and Submenu Commands and Options
    a. Highlight the first item on a menu bar (Alt or F10)
    b. Open and close a menu (Alt + Underline Character)
    c. Open and close a submenu (Underline Character)
    d. Close a menu or submenu (Esc)
    e. Open the Control menu of the current application window (Alt + Space bar)
    f. Open the Control menu of the current document window (Alt + Hyphen)
4. Manipulate Dialog Box Options
    a. Close and cancel a dialog box (Esc)
    b. Cycle forward through the options (Tab)
    c. Cycle backward through the options (Shift + Tab)
    d. Move to the first item in a list (Home)
    e. Move to the last item in a list (End)
    f. Select all items in a list (Ctrl + Slash)

g. Deselect all items in a list, except for the current selection (Ctrl + Backslash)
h. Select the highlighted command button (Enter)
i. Toggle a highlighted check box (Space bar)
j. Choose option button and highlight item in a list (Arrow Keys)
k. Activate a command button containing an underlined character (Alt + Underlined Character)
l. Highlight an option containing an underlined character (Alt + Underlined Character)
m. Toggle a check-box item containing an underlined character (Alt + Underlined Character)
n. Select the option button containing an underlined character (Alt + Underlined Character)

**F. DEMONSTRATE USE OF COMPUTER COMMUNICATION SYSTEMS**

1. Describe Theory of Communication as Related to:
   a. CNC machines
   b. Computer networks
   c. Computer Bulletin boards using modem
   d. Internet
2. Punch and Load Tape Medium
   a. Describe various standards of tape medium
   b. Punch tape to load program into machine
   c. Punch tape of edited program at machine
3. Use Electronic Communications to Load CNC Programs
   a. Download and upload CNC programs using:
      (1) RS-232 interface
      (2) Communication section of CAD/CAM software
      (3) Windows software
      (4) Local area networks
      (5) Bi-directional communication (handshaking)
      (6) Direct Numerical Control
      (7) Distributive numerical control

**G. DEMONSTRATE ABILITY TO START CNC VERIFICATION PROGRAMS**

1. Choose Software for Verification
   a. Describe verification process
   b. Describe traits of various software packages
   c. Explain applications of different software packages
   d. List and identify appropriate software packages based on:
      (1) Cost, Hardware requirements, Project requirements, Multi axes machining, Milling or turning & operating system
   e. Describe and identify functions of file names and extensions
2. Load Software
   a. Install DOS based software
   b. Install Windows based software
   c. Configure software
3. Start Conversion Process for Verification Programs
   a. Describe conversion process from NC program to verification format
   b. Start PC

c. Start conversion process
d. Answer questions required in conversion process

**H. PROGRAM AND CREATE CNC VERIFICATION USING PROGRAM ICONS**

1. Describe Verification Software
   a. Start software
   b. Describe menu structure
   c. Describe file extension formats and uses
   d. Describe various sections of display
   e. Describe information displayed by software
2. Program Material Data Using Stock Functions
   a. Identify Stock icon
   b. Define type of material stock
   c. Define length, width and height of stock
   d. Load stock files
   e. Rotate stock as needed
   f. Translate part home position to stock location
   g. Use accept and cancel options
3. Program View Using View Functions
   a. Identify View icon
   b. Rotate light source for different effects
   c. Change shade types and explain results
   d. Change view scale and explain results
   e. Rotate view as required
   f. Use accept, cancel, window and preview options
4. Select Color Using Color Selection Functions.
   a. Identify Color Selection icon
   b. Select choices in Color menu to include shading calculation for best results
   c. Use accept or cancel options, as required
   d. Describe and explain choices used in selection(s)
5. Program Cutting Set-up Using Cut Functions
   a. Identify Cut icon
   b. Select choices in Cut Set-Up menu to:
      (1) Set resolution and describe results
      (2) Set cutter display and describe results
   c. Describe skip cut question and result
   d. Define path and filename of TP (APT) file
6. Program Snap Shots Using Snap Shot Functions
   a. Identify Snap Shot icon
   b. Select choices in Snap-Shot menu to:
      (1) Define file extension typically used for different applications
      (2) Load existing snapshot "Picture" file
      (3) Save single snapshot file
      (4) Control snap-shot frequency
   c. Use auto save features, as required
   d. Use auto-error detection
7. Create Cross Section Using Cross Section Functions
   a. Identify Cross Section icon
   b. Select choices in Cross Section menu to include:

(1) Cross sectioning by plane numbers
(2) Cross sectioning by plane type
(3) Define options choice

8. Manipulate Zoom Functions
   a. Identify Zoom icon
   b. Select choices in Zoom menu to include:
      (1) Zoom mode, Zoom Resolution, Scale factors
9. Program Views of Model Using Model Functions
   a. Identify Model icon
   b. Select choices in Model menu to include:
      (1) Translucent, Reverse, Display & Cut models
10. Program Tool Path Using Tool Path Functions
   a. Identify Tool Path Control icon
   b. Select choices in Tool Path menu to include:
      (1) Tool path code type
      (2) Machine type (Milling or Turning)
      (3) Multi-axis
      (4) Rotational choices
11. Program Use of Tools Using Tool Control Functions
   a. Identify Tool Control icon
   b. Select choices in Tool Control menu to include:
      (1) Cutter, Shank & Holder selections
12. Program Playback of Program Using Playback Functions
   a. Identify Playback icon
   b. Select choices in Playback menu to:
      (1) Record verification session
      (2) Play back verification session
   c. Describe benefits and drawbacks of recorded sessions
13. Select and Manipulate User File Functions
   a. Identify User File icon
   b. Define reasons for using user files
   c. Select choices in User File menu to:
      (1) Define file extension for user file information
      (2) Save user file information
      (3) Load existing user file information
14. Create Graphic Image Using Shade Copy Functions
   a. Identify Shade Copy icon
   b. Select choices in Shade Copy menu to include:
      (1) Type of shadecopy
      (2) Auto save and error functions
      (3) Shading method
      (4) Page orientation
      (5) Using the TIFF format
      (6) Output device
      (7) Using the EPSF format
      (8) Retrieving, converting various graphic file formats
15. Analyze Measurement Using X-Caliper Functions
   a. Identify X-caliper icon

b. Select choices in X-caliper menu to measure:
(1) Distance and angles
(2) Points
(3) Stock thickness
(4) Air thickness
(5) Features

16. Execute Use of Holding Devices Using Fixture Functions
a. Identify Fixture Icon
b. Select choices in Fixture menu to include:
(1) Import fixtures
(2) Define path and file to import
(3) Describe plus and minus for fixture display

**I. PROGRAM CNC VERIFICATION USING PULL-DOWN MENUS**

1. Select Pull-Down Menu Program
a. Start Program
b. Select and describe which format to verify:
(1) NC code
(2) Intermediate files
(3) Describe strengths and limitations of verifying each

2. Select Options From File Menu
a. Select and answer appropriate questions:
(1) NC program
(2) Define measurement units
(3) Set-up file
(4) Translate NC code to RVP file if needed
(5) Stock parameters
(6) Define and describe upgrades available
(7) Define tools
(8) Choose preferred editor
(9) Define machine controller
b. Explain selected options

3. Select Options from Options Menu
a. Select and answer appropriate questions:
(1) Pause process options
(2) Axis rotation of model
(3) Step size options
(4) Light source rotation onto model
(5) Rapid threshold feed rate
(6) Stl file import for surface comparison
(7) Spindle check for rotation and direction
(8) Calculation for milling cycle time
(9) Volume of material removed during machining
b. Explain selected options

4. Describe Model Selection Options
a. Describe application, strengths and limitations of:
(1) Preview
(2) Verify
(3) Turbo

5. Select Examine Selection Options
   a. Select and use Examine Selection options to include:
      (1) X-Section "cross section"
      (2) Color tools option
      (3) CMM inspection
      (4) Zoom functions
      (5) Measurement
6. Select Window Selection Options
   a. Select and use Window Selection options to include:
      (1) Statistics On/Off
      (2) Maximize window
      (3) NC file display On/Off
      (4) Tile command
      (5) Control display On/Off
7. Use Help Menu Options
   a. Locate and describe Help Menu options to include:
      (1) Contents of Help menu
      (2) Memory information for applications
      (3) Search for help on topic
      (4) Version call out for software
      (5) Instructions on how to use help menu
8. Use Control Menu Options
   a. Describe and use:
      (1) Control go
      (2) Control restart
9. Perform Centerline Verification of Program
   a. Describe uses of backplotting
   b. Start appropriate software
   c. Describe nomenclature of various software applications
   d. Describe strength and limitations of back plotting
   e. Select various menu settings for desired results
   f. Run backplotting procedure
10. Program Graphics Option on Controller
   a. Load program into controller
   b. Set menu settings to appropriate positions
   c. Start graphic verification on controller
11. Access and Use Modem Connection
   a. Describe how modems communicate
   b. Describe various standards and settings used in communication
   c. Change modem and software settings
   d. Describe various software for modem use
   e. Connect to Electronic Bulletin Board
   f. Download and upload files from Bulletin Board
   g. Describe Internet
   h. Log on to Internet and search for material
   i. Download and upload information on Internet

## COURSE OBJECTIVES: SCANS COMPETENCIES

*The Secretary's Commission on Achieving Necessary Skills (SCANS), U.S. Department of Labor, has identified in its "AMERICA 2000 REPORT" that all students should develop a new set of competencies and foundation skills if they are to enjoy a productive, full and satisfying life. These are in addition to the Technical Workplace Competencies required by industry. SCANS is made up of five competencies and a three-part foundation of skills and personal qualities that are needed for solid job performance.*

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The following activities will be performed by each student for successful completion of this course:

**I. COMPETENCIES**

*A.* ***Resources:*** *Identifies, organizes, plans, and allocates resources*
1. follows a schedule to complete assigned tasks on time
2. determine the initial cost of materials and "value added" as result of machining
3. provide a self-evaluation of performance based on the time and quality of work

*B.* ***Interpersonal:*** *Works with others*
1. complete assigned responsibilities within the shop floor serving as a member of the team
2. provide individual assistance/direction to peers as requested
3. produce machine parts to acceptable levels of quality as required
4. works well with all members of the class

*C.* ***Information:*** *Acquires and uses information*
1. read and interpret blueprints
2. organize and apply theories of machine tool operation

*D.* ***Systems:*** *Understands complex inter-relationships*
1. demonstrate knowledge of the following systems:
   a. laboratory organization structure: physical and social
   b. organization of personnel and facilities on the shop floor
   c. systematic approach to the metal removal process
   d. dimensioning and measurement systems
   e. systematic organization of training materials
2. monitors and corrects performance during
   a. the machining process
   b. adjustments of individual laboratory work schedule
   c. constantly evaluating the quality of work to achieve acceptable standards
   d. maintains record of evaluations and sets individual goals

*E.* ***Technology:*** *Works with a variety of technologies*
1. chooses procedure, tools and equipment required to produce a part
2. applies appropriate procedures and uses appropriate tools and equipment to produce a machined part to acceptable standards
3. maintains and troubleshoots equipment
   a. applies appropriate preventative maintenance

b. when operating machines
c. reports all malfunctions of equipment to supervisor/instructor
d. perform clean-up assignments of machine and shop floor at the end of the laboratory

## II. FOUNDATION SKILLS

*A.* ***Basic Skills:*** *Reads, writes, performs arithmetic and mathematical operations, listens and speaks.*

*1.* ***Reading:*** *Locates, understands, and interprets written information in prose and in documents such as manuals, graphs, and schedules*

a. studies student laboratory manual
b. interprets blueprints and technical drawings
c. read/studies textbook
d. follow a daily laboratory schedule to maintain appropriate time-line and product completion

*2.* ***Writing:*** *Communicates thoughts, ideas, information, and messages in writing; and creates documents such as letters, directions, manuals, reports, graphs, and flow charts*

a. outline the steps necessary to produce a simple machine part
b. maintain a lecture notebook
c. submit written responses to chapter question assignments
d. complete all written assignments

*3.* ***Arithmetic/Mathematics:*** *Perform basic computations and approaches practical problems by choosing appropriately from a variety of mathematical techniques*

a. determines optimum machining speeds, feeds, and depth of cut
b. calculates "value added to the part"
c. aligns machine and/or work holding device
d. taps and threads
e. keeps a running computation of individual grade
f. interconverts fractions to decimal expressions
g. use protractors to lay-out angle machining
h. use trigonometry to solve angle and taper calculations

*4.* ***Listening:*** *Receives, attends to, interprets, and responds to verbal messages and other cues*

a. assimilate classroom instruction
b. interpret and assimilate video instruction
c. observe laboratory demonstrations
d. seek and receive individualized instruction in the laboratory

*5.* ***Speaking:*** *Organizes ideas and communicates orally*

a. participates in classroom discussions
b. organize ideas and communicate specific questions to the instructor
c. verbally affirms understanding of a concept, procedure, or required skill
d. communicates with peers to ensure the smooth and safe operation of the laboratory

*B.* ***Thinking Skills:*** *Thinks creatively, makes decisions, solves problems, visualizes, knows how to learn and reasons.*

1. ***Decision Making:*** *Specifies goals and constraints, generates alternatives, considers risks, and evaluates and chooses best alternative*
   a. identifies personal goals
   b. identifies actions required to accomplish personal goals
2. ***Problem Solving:*** *Recognizes problems and devises and implements plan of action*
   a. makes daily accommodations to stay on schedule
   b. seeks additional instruction/clarification for assignment completion
   c. balances social and academic life/responsibilities
   d. accepts responsibility
3. ***Seeing Things In the Mind's Eye:*** *Organizes, and processes symbols, pictures, graphs, objects, and other information*
   a. interprets technical drawings
   b. interprets technical illustrations and symbols
   c. understands both written and verbal instructions
   d. assimilates process during instructor demonstrations
4. ***Knowing How to Learn:*** *Use efficient learning techniques to acquire and apply new knowledge and skills*
   a. demonstrate mastery of the basic skills and techniques
   b. use these sequential skills to support mastery of new skills
   c. understand the sequential nature of acquired skills and the subsequent knowledge application of new skills and techniques
5. ***Reasoning:*** *Discovers a rule or principle underlying the relationship between two or more objects and applies it when solving a problem*
   a. understands that practice may not make it perfect but it certainly will improve the skill of the operator
   b. understands that the quality of the product is a function of the time of the operation and the attitude and skill of the machinist
   c. understands the relationship between different metals and the tool applied to the metal surface and adjusts machining parameters accordingly

C. ***Personal Qualities:*** *Displays responsibility, self-esteem, sociability, self-management, and integrity and honesty.*
1. ***Responsibility:*** *Exerts a high level of effort and perseveres towards goal attainment*
   a. develops an understanding that in order to be successful you must be a "good" student
   b. develops an understanding that a "good" student is the one who is prompt to every class and has prepared for the day's work
   c. develops an understanding good students know what they are going to do in class and does not waste time
   d. develops a fine work-ethic
2. ***Self-Esteem:*** *Believes in own self-worth and maintains a positive view of self*
   a. learns to take pride in his or her work through positive reinforcement
   b. sees himself or herself as an asset to the class through continued contributions to the group and a shared common goal

c. understands that an individual with a positive attitude and the belief in their own abilities will systematically seek solutions and be a valuable employee

3. ***Sociability:*** *Demonstrates understanding, friendliness, adaptability, empathy, and politeness in group settings*
   a. assist classmates in improving technical skills
   b. assist students with special needs as a peer mentor
   c. share laboratory resources (machines, tools and instructor's individual attention)

4. ***Self-Management:*** *Assesses self accurately, sets personal goals, monitors progress, and exhibits self-control*
   a. perform in-process quality checks on machined parts
   b. maintain a record of academic achievement (individual grade book)
   c. make accommodations to laboratory schedules due to broken machines/tools
   d. accept the responsibility for self-management

5. ***Integrity/Honesty:*** *Chooses ethical courses of action*
   a. accept the responsibility for own actions
   b. exhibit personal honesty at all times
   c. accept the challenge of doing your own work in the laboratory, during examination, and on outside assignments
   d. understand the consequences of unethical behaviors

***M*achine Tool *A*dvanced *S*kills**
***T*echnology Program**

# MAST

## COURSE SYLLABUS

## INTRODUCTION TO CAD/CAM

# MAST PROGRAM
## COURSE SYLLABUS
## INTRODUCTION TO CAD/CAM

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**Lecture hours/week: 3** **Lab hours/week: 3** **Credit hours: 4**

**COURSE DESCRIPTION:**

Introduction to CAD/CAM theory's and software. The emphasis will be on the generation of CNC programs, at a basic level, for both CNC Mill, and CNC Lathe. (FT) Transfer Credit: CSU

**PREREQUISITES:** **Concurrent enrollment, or completion with "C" or above, in Introduction to CNC Verification and Communication**

**COURSE OBJECTIVES:**

Each student successfully completing this course will:

1. Demonstrate the correct use of CAD/CAM software to generate basic 2 dimensional shapes
2. Demonstrate the use of the post-processor and co-processor for intermediate CNC data
3. Properly identify various parts of CNC program generation
4. Perform editing of CNC programs using various software
5. Demonstrate use of communications module within CAD/CAM software
6. Demonstrate proper use of personal computers
7. Demonstrate a basic understanding of the common DOS and Windows commands as used on personal computers
8. Demonstrate reading and writing skills to read and prepare required documents for course work
9. Demonstrate communication skills to interact successfully with members of working teams and instructor

**REQUIRED COURSE MATERIALS:**

**Textbooks:** Examples of appropriate textbooks include:
**MasterCam For Windows**, 1995
**SmartCam Programming Manual**, 1992
**Anilam Vertical Machining Program Manual**, 1991
**Bendix Dynapath Manual**, 1989
**Fadal Programming Manual**, 1992
**Fanuc 6T Programming Manual**, 1988
**Greco System Manual**, 1992
**Surfcam Programming Manual**, Current Edition

**Hand Tool/Supplies:** Examples of appropriate supplies include:
Computer Diskettes

**METHOD OF INSTRUCTION:**

**Lecture:** Presentations will include:

1. Lecture with, or without, various audio-visual aids
2. Discussion, debate, and/or critique
3. Demonstration
4. Computer-assisted or other self-paced instruction
5. Field trips or field assignments
6. Laboratory assignments utilizing specifically planned instructional activities or "live" work.

**Laboratory:** Laboratory will be a "hands-on" process.

**Writing Assignments:** Writing assignments include:

1. Completing assigned reports
2. Providing written answers to assigned questions
3. Performing arithmetic calculations as assigned
4. Maintaining a notebook of class assignments and activities
5. Completing a 500 word written report dealing with a subject related to this course

**Appropriate Outside Assignments:** Students are expected to spend a minimum of two hours outside of class in practice and preparation for each hour of theory in class. Appropriate assignments include:

1. Researching appropriate readings
2. Preparing research reports
3. Preparing writing assignments
4. Studying as needed to perform successfully in class

**Appropriate Assignments That Demonstrate Critical Thinking:**

1. Students will be required to demonstrate verification and communication of their own programs.
2. Students must estimate machining time involved in producing a programmed work piece.
3. Students will interpret blueprints to produce required machine parts to specifications in the time allowed.
4. Students will be required to demonstrate using the basic DOS and Windows commands of a personal computer.
5. Students will be required to verify and communicate supplied programs, and make corrections and recommendations for efficiency and safety.

**Method of Evaluation:** A student's grade will be based on multiple measures of performance. The assessment will measure development of independent critical thinking skills and will include evaluation of the student's ability to:

1. perform the manipulative skills of the craft as required to satisfactorily complete laboratory assignments
2. apply theory to laboratory assignments
3. satisfactorily perform on written, oral, or practical examinations
4. satisfactorily perform on outside assignments including writing assignments
5. contribute to class discussions

6. maintain attendance per current policy
7. follow all laboratory rules and safety regulations

**LECTURE OUTLINE:**

| Lecture Topics | Text Reference Page | Contact Hrs. |
|---|---|---|
| **Basic Geometry Generation** | | |
| A. Contours | | |
| B. Pockets | | |
| C. Lettering | | |
| D. Drilling | | |
| **Basic Toolpaths Generation** | | |
| A. Contours | | |
| B. Pockets | | |
| C. Lettering | | |
| D. Drilling | | |
| **Tooling Parameters** | | |
| A. Definition of materials | | |
| B. Definition of tool files | | |
| C. Discussion of speeds, and feeds | | |
| D. Discussion of cutting tools and geometries | | |
| **Intermediate Files** | | |
| A. Backplotting completed intermediate files | | |
| B. Editing intermediate files | | |
| C. Merging intermediate files | | |
| D. Projection of intermediate files | | |
| **Generating CNC Code** | | |
| A. Selection of post, or co-processors | | |
| B. Operation of post, or co-processors | | |
| C. Reverse postprocessing | | |
| **Communication parameters** | | |
| A. RS-232 interface | | |
| B. Downloading | | |
| C. Uploading | | |
| D. Handshaking | | |
| E. Greco System's communication | | |
| **Controls Parameters** | | |
| A. Fadal Controller | | |
| B. Desk top P.C.S. | | |
| C. Anilam Control | | |
| D. Fanuc Control | | |
| E. Dynapath System 10 | | |
| **Personal Computers** | | |

A. Basic terminology
B. Basic operation
C. Basic DOS commands

**Total Lecture Hours** —

**LAB OUTLINE:**

| Lab Topics | Contact Hrs. |
|---|---|
| **Basic Geometry Generation** | |
| A. Contours | |
| B. Pockets | |
| C. Lettering | |
| D. Drilling | |
| **Basic Toolpaths Generation** | |
| A. Contours | |
| B. Pockets | |
| C. Lettering | |
| D. Drilling | |
| **Tooling Parameters** | |
| A. Definition of materials | |
| B. Definition of tool files | |
| C. Discussion of speeds, and feeds | |
| D. Discussion of cutting tools and geometries | |
| **Intermediate Files** | |
| A. Backplotting completed intermediate files | |
| B. Editing intermediate files | |
| C. Merging intermediate files | |
| D. Projection of intermediate files | |
| **Generating CNC Code** | |
| A. Selection of post, or co-processors | |
| B. Operation of post, or co-processors | |
| C. Reverse postprocessing | |
| **Communication parameters** | |
| A. RS-232 interface | |
| B. Downloading | |
| C. Uploading | |
| D. Handshaking | |
| E. Greco System's communication | |
| **Controls Parameters** | |
| A. Fadal Controller | |
| B. Desk top P.C.S. | |
| C. Anilam Control | |
| D. Fanuc Control | |
| E. Dynapath System 10 | |
| **Personal Computers** | |
| A. Basic terminology | |
| B. Basic operation | |
| C. Basic DOS commands | |



**Total Lab Hours** —

## COURSE OBJECTIVES: TECHNICAL COMPETENCIES

After the successful completion of this course the student will be able to:

**A. DEMONSTRATE UNDERSTANDING OF CAD/CAM PROGRAMS**

1. Explain CAD/CAM Programs
   - a. Define Computer Aided Design (CAD)
   - b. Define Computer Aided Manufacturing (CAM)
   - c. Describe common applications of CAD and CAM
   - d. Discuss common CAD packages to include:
     - (1) AutoCad
     - (2) CadKey
     - (3) Micro Station
   - e. Discuss Common CAM packages to include:
     - (1) MasterCam
     - (2) SurfCam
     - (3) SmartCam
   - f. Describe common applications of each CAM package
2. Explain file extension functions to include:
   - a. *.GE3 / *.DSN
   - b. *.NCI / *.INC
   - c. *.PST / *.M3
   - d. *.NC / *.NCC

**B. ACCESS CAD PROGRAM OPTIONS**

1. Explain the Configuration of CAD/CAM Software
   - a. Explain configuration of:
     - (1) File and path names
     - (2) Installation including DOS and Windows
     - (3) Configure software
     - (4) Interaction of files between each other
   - b. Describe the "Flow" process of CAD/CAM
2. Access CAD Software
   - a. Access CAD software, including AutoCad and CadKey, to:
     - (1) Create basic 2-dimensional designs
     - (2) Create 3-dimension designs
     - (3) Dimension designs to be used as drawings
     - (4) Create title blocks and borders for prints
     - (5) Print drawings
     - (6) Plot drawings
     - (7) Create general and local drawing notes and tolerances
   - b. Describe various file conversion formats
   - c. Import and export designs using conversions, including:
     - (1) IGES
     - (2) CADL
     - (3) DXF
     - (4) STL
3. Access CAM Software
   - a. Load existing design

b. Import and export design files from various file format standards, including:
   (1) IGES
   (2) DXF
   (3) CADL
   (4) STL
c. Save design files to "permanent" memory
d. Set menu selections to:
   (1) View planes
   (2) Construction planes
   (3) Color choices

**C. CREATE DESIGNS WITH CAD SECTION OF CAD/CAM PROGRAM**

1. Create Basic Geometric Entities
   a. Create basic geometric entities, including:
      (1) Points
      (2) Fillets
      (3) Lines
      (4) Splines
      (5) Arcs
      (6) Chamfers
      (7) Circles
      (8) Letters including various machinable fonts
   b. Dimension completed designs to create detailed drawings
2. Transform Geometric Entities using CAD Commands
   a. Transform geometric entities, including:
      (1) Mirror entities
      (2) Rotate entities
      (3) Scale complete entities using single scale option
      (4) Translate using move and copy options
      (5) Offset single and grouped geometric entities
      (6) Use group function to effect multiple entities simultaneously
      (7) Use result function to effect group movements

**D. DEMONSTRATE ABILITY TO USE PROGRAM FUNCTIONS**

1. Execute File Function
   a. Execute file functions to:
      (1) Save and retrieve files
      (2) Read and write common file conversion standards
      (3) Print numerical control program
      (4) Print design to printer
      (5) Send design to plotter
      (6) Send and receive CNC data
2. Use Delete Command
   a. Use Delete commands, including:
      (1) Chained and duplicate entities
      (2) Exclusive entities (only)
      (3) Inclusive entities (all)
      (4) Enclosed in Window
      (5) Intersecting Window
3. Execute Screen and Display Functions

a. Use screen and display functions to:
(1) List screen statistics
(2) Display entity endpoints
(3) Clear group and result color designation
(4) Change colors of entities
(5) Display window
(6) Un-Zoom display
(7) Change levels of entities
(8) Fit entities to screen
(9) Set various view ports
(10) Refresh screen
(11) Change views
(12) Set active levels
(13) Change entities between levels
(14) Set screen center "Pan"
(15) Initialize display "clear"
(16) Rotate display

4. Use Analyze function
a. Use Analyze Function to interpret:
(1) Point descriptions
(2) Single entity information
(3) Locations of entities
(4) Distance between points
(5) Area calculations
(6) Calculation of angles
(7) Surface information

**E. PROCESS TOOL PATH DATA**

1. Generate Numerical (NC) Code
a. Generate NC code to access:
(1) Turning Center "Lathe"
(2) Vertical Machining Center "Mill"

2. Generate Basic Vertical Machining Code
a. Generate basic vertical machining code for operations, including:
Outside and inside contours
Pocketing operations
Drilling, reaming, spot drilling, tapping operations

3. Edit Tool Path Data Files
a. View and edit tool path data files, including:
(1) Display centerline tool path
(2) Calculate time to machine
(3) Filter tool path data to reduce size and time
Change feed rates and compare results
(4) Edit tool path data to change possible variables
(5) Define tool selections and operating parameters
(6) Define materials to be machined
(7) Create set-up document
b. Cut part as solid model

4. Process Tool Path Data to Numerical Control Code
a. Select post processing file relative to machine tool being used

b. Execute post processing function
c. Edit numerical control program if needed

5. Describe and Execute Post-Processor or Co-processor Functions
   a. Describe post-processor and co-processor functions
   b. Run processors

## COURSE OBJECTIVES: SCANS COMPETENCIES

*The Secretary's Commission on Achieving Necessary Skills (SCANS), U.S. Department of Labor, has identified in its "AMERICA 2000 REPORT" that all students should develop a new set of competencies and foundation skills if they are to enjoy a productive, full and satisfying life. These are in addition to the Technical Workplace Competencies required by industry. SCANS is made up of five competencies and a three-part foundation of skills and personal qualities that are needed for solid job performance.*

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The following activities will be performed by each student for successful completion of this course:

### I. COMPETENCIES

*A.* ***Resources:*** *Identifies, organizes, plans, and allocates resources*
1. follows a schedule to complete assigned tasks on time
2. determine the initial cost of materials and "value added" as result of machining
3. provide a self-evaluation of performance based on the time and quality of work

*B.* ***Interpersonal:*** *Works with others*
1. complete assigned responsibilities within the shop floor serving as a member of the team
2. provide individual assistance/direction to peers as requested
3. produce machine parts to acceptable levels of quality as required
4. works well with all members of the class

*C.* ***Information:*** *Acquires and uses information*
1. read and interpret blueprints
2. organize and apply theories of machine tool operation

*D.* ***Systems:*** *Understands complex inter-relationships*
1. demonstrate knowledge of the following systems:
   a. laboratory organization structure: physical and social
   b. organization of personnel and facilities on the shop floor
   c. systematic approach to the metal removal process
   d. dimensioning and measurement systems
   e. systematic organization of training materials
2. monitors and corrects performance during
   a. the machining process
   b. adjustments of individual laboratory work schedule
   c. constantly evaluating the quality of work to achieve acceptable standards
   d. maintains record of evaluations and sets individual goals

*E.* ***Technology:*** *Works with a variety of technologies*

1. chooses procedure, tools and equipment required to produce a part
2. applies appropriate procedures and uses appropriate tools and equipment to produce a machined part to acceptable standards
3. maintains and troubleshoots equipment
   a. applies appropriate preventative maintenance
   b. when operating machines
   c. reports all malfunctions of equipment to supervisor/instructor
   d. perform clean-up assignments of machine and shop floor at the end of the laboratory

## II. FOUNDATION SKILLS

*A.* ***Basic Skills:*** *Reads, writes, performs arithmetic and mathematical operations, listens and speaks.*

*1.* ***Reading:*** *Locates, understands, and interprets written information in prose and in documents such as manuals, graphs, and schedules*

   a. studies student laboratory manual
   b. interprets blueprints and technical drawings
   c. read/studies textbook
   d. follow a daily laboratory schedule to maintain appropriate time-line and product completion

*2.* ***Writing:*** *Communicates thoughts, ideas, information, and messages in writing; and creates documents such as letters, directions, manuals, reports, graphs, and flow charts*

   a. outline the steps necessary to produce a simple machine part
   b. maintain a lecture notebook
   c. submit written responses to chapter question assignments
   d. complete all written assignments

*3.* ***Arithmetic/Mathematics:*** *Perform basic computations and approaches practical problems by choosing appropriately from a variety of mathematical techniques*

   a. determines optimum machining speeds, feeds, and depth of cut
   b. calculates "value added to the part"
   c. aligns machine and/or work holding device
   d. taps and threads
   e. keeps a running computation of individual grade
   f. interconverts fractions to decimal expressions
   g. use protractors to lay-out angle machining
   h. use trigonometry to solve angle and taper calculations

*4.* ***Listening:*** *Receives, attends to, interprets, and responds to verbal messages and other cues*

   a. assimilate classroom instruction
   b. interpret and assimilate video instruction
   c. observe laboratory demonstrations
   d. seek and receive individualized instruction in the laboratory

*5.* ***Speaking:*** *Organizes ideas and communicates orally*

   a. participates in classroom discussions
   b. organize ideas and communicate specific questions to the instructor

c. verbally affirms understanding of a concept, procedure, or required skill
d. communicates with peers to ensure the smooth and safe operation of the laboratory

*B.* ***Thinking Skills:*** *Thinks creatively, makes decisions, solves problems, visualizes, knows how to learn and reasons.*

*1.* ***Decision Making:*** *Specifies goals and constraints, generates alternatives, considers risks, and evaluates and chooses best alternative*
a. identifies personal goals
b. identifies actions required to accomplish personal goals

*2.* ***Problem Solving:*** *Recognizes problems and devises and implements plan of action*
a. makes daily accommodations to stay on schedule
b. seeks additional instruction/clarification for assignment completion
c. balances social and academic life/responsibilities
d. accepts responsibility

*3.* ***Seeing Things In the Mind's Eye:*** *Organizes, and processes symbols, pictures, graphs, objects, and other information*
a. interprets technical drawings
b. interprets technical illustrations and symbols
c. understands both written and verbal instructions
d. assimilates process during instructor demonstrations

*4.* ***Knowing How to Learn:*** *Use efficient learning techniques to acquire and apply new knowledge and skills*
a. demonstrate mastery of the basic skills and techniques
b. use these sequential skills to support mastery of new skills
c. understand the sequential nature of acquired skills and the subsequent knowledge application of new skills and techniques

*5.* ***Reasoning:*** *Discovers a rule or principle underlying the relationship between two or more objects and applies it when solving a problem*
a. understands that practice may not make it perfect but it certainly will improve the skill of the operator
b. understands that the quality of the product is a function of the time of the operation and the attitude and skill of the machinist
c. understands the relationship between different metals and the tool applied to the metal surface and adjusts machining parameters accordingly

*C.* ***Personal Qualities:*** *Displays responsibility, self-esteem, sociability, self-management, and integrity and honesty.*

*1.* ***Responsibility:*** *Exerts a high level of effort and perseveres towards goal attainment*
a. develops an understanding that in order to be successful you must be a "good" student
b. develops an understanding that a "good" student is the one who is prompt to every class and has prepared for the day's work
c. develops an understanding good students know what they are going to do in class and does not waste time
d. develops a fine work-ethic

2. ***Self-Esteem:*** *Believes in own self-worth and maintains a positive view of self*
   a. learns to take pride in his or her work through positive reinforcement
   b. sees himself or herself as an asset to the class through continued contributions to the group and a shared common goal
   c. understands that an individual with a positive attitude and the belief in their own abilities will systematically seek solutions and be a valuable employee
3. ***Sociability:*** *Demonstrates understanding, friendliness, adaptability, empathy, and politeness in group settings*
   a. assist classmates in improving technical skills
   b. assist students with special needs as a peer mentor
   c. share laboratory resources (machines, tools and instructor's individual attention)
4. ***Self-Management:*** *Assesses self accurately, sets personal goals, monitors progress, and exhibits self-control*
   a. perform in-process quality checks on machined parts
   b. maintain a record of academic achievement (individual grade book)
   c. make accommodations to laboratory schedules due to broken machines/tools
   d. accept the responsibility for self-management
5. ***Integrity/Honesty:*** *Chooses ethical courses of action*
   a. accept the responsibility for own actions
   b. exhibit personal honesty at all times
   c. accept the challenge of doing your own work in the laboratory, during examination, and on outside assignments
   d. understand the consequences of unethical behaviors

*M*achine Tool *A*dvanced *S*kills
*T*echnology Program

# MAST

# COURSE SYLLABUS

# APPLICATIONS OF CAD/CAM I

# MAST PROGRAM
## COURSE SYLLABUS
## APPLICATIONS OF CAD/CAM I

**Lecture hours/week: 0** **Lab hours/week: 6** **Credit hours: 2**

**COURSE DESCRIPTION:**

Exercises in CAD/CAM to increase students efficiency and quality of work on the generation of CNC programs, at an intermediate level, for both CNC Mill and CNC Lathe. (FT) Transfer Credit: CSU.

**PREREQUISITES:** **Concurrent enrollment, or completion with "C" or above, in Introduction to CAD/CAM**

**COURSE OBJECTIVES:**

Each student successfully completing this course will:

1. Demonstrate use of CAD/CAM software to create 2 dimensional designs and required tool paths at an intermediate level of quality and quantity of projects
2. Demonstrate the use of post-processor and co-processor for intermediate CNC data at an intermediate level
3. Complete assigned projects using required skills with limited hands-on instruction by the instructor
4. Perform editing of CNC programs using various software
5. Demonstrate use of communications module within CAD/CAM software
6. Demonstrate proper use of personal computers
7. Demonstrate a basic understanding of the common DOS and Windows commands as used on personal computers
8. Demonstrate increased productivity, efficiency, and independent problem solving techniques
9. Demonstrate reading and writing skills to read and prepare required documents for course work
10. Demonstrate communication skills to interact successfully with members of working teams and instructor

**REQUIRED COURSE MATERIALS:**

**Textbooks**: Examples of appropriate textbooks include:
**MasterCam For Windows**, 1995
**SmartCam Programming Manuals**, 1992
**Anilam Vertical Machining Program Manual**, 1991
**Bendix Dynapath Manual**, 1989
**Fadal Programming Manual**, 1992
**Fanuc 6T Programming Manual**, 1988

**Greco Systems Manual**, 1992
**Surfcam Programming Manual**, Current Edition

**Hand Tools/Supplies:** Computer Diskettes

**METHOD OF INSTRUCTION:**

The appropriate method of instruction will be determined by each instructor and may include:

1. Lecture with, or without, various audio-visual aids
2. Discussion, debate, and/or critique
3. Demonstration
4. Computer-assisted or other self-paced instruction
5. Field trips or field assignments
6. Laboratory assignments utilizing specifically planned instructional activities or "live" work.

**Writing Assignments:** Writing assignments include:

1. Completing assigned reports
2. Providing written answers to assigned questions
3. Performing arithmetic calculations as assigned
4. Maintaining a notebook of class assignments and activities
5. Completing a 500 word report dealing with a subject related to this course.

**Appropriate Outside Assignments:** Students are expected to spend a minimum of two hours outside of class in practice and preparation for each hour in class. Appropriate assignments include:

1. Researching appropriate readings
2. Preparing research reports
3. Preparing writing assignments
4. Studying as needed to perform successfully in class

**Appropriate Assignments That Demonstrate Critical Thinking:**

1. Students will be required to demonstrate verification and communication of their own programs.
2. Students must estimate machining time involved in producing a programmed work piece.
3. Students will interpret blueprints to produce required machine parts to specifications in the time allowed.
4. Students will be required to demonstrate using the basic DOS and Windows commands of a personal computer.
5. Students will be required to verify and communicate supplied programs, and make corrections and recommendations for efficiency and safety.

**Method of Evaluation:** A student's grade will be based on multiple measures of performance. The assessment will measure development of independent critical thinking skills and will include evaluation of the student's ability to:

1. perform the manipulative skills of the craft as required to satisfactorily complete laboratory assignments

2. apply theory to laboratory assignments
3. satisfactorily perform on written, oral, or practical examinations
4. satisfactorily perform on outside assignments including writing assignments
5. contribute to class discussions
6. maintain attendance per current policy
7. follow all laboratory rules and safety regulations

**LAB OUTLINE:**

| LabTopics | Contact Hrs. |
|---|---|

**Basic Geometry Generation**

A. Contours
B. Pockets
C. Lettering
D. Drilling
E. Ruled Shapes
F. Swept Geometries
G. Revolution
H. Projection

**Basic Toolpaths Generation**

A. Contours
B. Pockets
C. Lettering
D. Drilling
E. Ruled Shapes
F. Swept Geometries
G. Revolution
H. Projection

**Tooling Parameters**

A. Definition of materials
B. Definition of tool files
C. Discussion of speeds, and feeds
D. Discussion of cutting tools and geometries

**Intermediate Files**

A. Backplotting completed intermediate files
B. Editing intermediate files
C. Merging intermediate files
D. Projection of intermediate files

**Generating CNC Code**

A. Selection of post, or co-processors
B. Operation of post, or co-processors
C. Reverse postprocessing

**Communication Parameters**

A. RS-232 Interface
B. Downloading
C. Uploading
D. Handshaking
E. Greco System's Communication

**Controls Parameters**

A. Fadal Controller
B. Desk Top P.C.S.
C. Anilam Control
D. Fanuc Control
E. Dynapath System 10

**Personal Computers**

A. Basic terminology
B. Basic operation
C. Basic DOS commands

**Total Lab Hours** —

## COURSE OBJECTIVES: TECHNICAL COMPETENCIES

After the successful completion of this course the student will be able to:

**A. CREATE DESIGNS WITH CAD SECTION OF CAD/CAM PROGRAM**

1. Create Geometric Entities at an Intermediate Level
   a. Create geometric entities with intermediate quality and quantity of projects including:
      (1) Points
      (2) Fillets
      (3) Lines
      (4) Splines
      (5) Arcs
      (6) Chamfers
      (7) Circles
      (8) Letters including various machinable fonts
   b. Dimension completed designs to create detailed drawings
2. Transform Geometric Entities using CAD Commands
   a. Transform geometric entities with intermediate quality and quantity of projects including:
      (1) Mirror entities
      (2) Rotate entities
   b. Scale complete entities using single scale option
   c. Translate using move and copy options
   d. Offset single and grouped geometric entities
   e. Use group function to effect multiple entities simultaneously
   f. Use result function to effect group movements

**B. DEMONSTRATE ABILITY TO USE PROGRAM FUNCTIONS**

1. Use Program Functions to Create Design at intermediate level, including:
   a. Execute file functions to:

(1) Save and retrieve files
(2) Read common file conversion standards
(3) Write common file conversion standards
(4) Print numerical control program
(5) Print design to printer
(6) Send design to plotter
(7) Send and receive CNC data

b. Use Delete commands, including:
(1) Chained entities
(2) Duplicate entities
(3) Exclusive entities (only)
(4) Inclusive entities (all)
(5) Enclosed in Window
(6) Intersecting Window

c. Execute screen and display Functions to:
(1) List screen statistics
(2) Fit entities to screen
(3) Display entity endpoints
(4) Set various view ports
(5) Clear group and result color designation
(6) Refresh screen
(7) Change colors of entities
(8) Change views
(9) Set active levels
(10) Change entities between levels
(11) Display window
(12) Set screen center "Pan"
(13) Un-Zoom display
(14) Initialize display "clear"
(15) Change levels of entities
(16) Rotate display

d. Use Analyze Function to interpret:
(1) Point descriptions
(2) Area calculations
(3) Single entity information
(4) Calculation of angles
(5) Locations of entities
(6) Surface information
(7) Distance between points

**C. PROCESS TOOL PATH DATA**

1. Generate Tool Path Codes to Create Designs with intermediate Level of Quality and Quantity of Projects.

a. Generate NC code to access:
(1) Turning Center "Lathe"
(2) Vertical Machining Center "Mill"

b. Generate basic vertical machining code for operations, including:
(1) Outside and inside contours
(2) Pocketing operations

(3) Drilling, reaming, spot drilling, tapping operations

2. Edit Tool Path Codes
   a. View and edit Tool Path data files, including:
      (1) Display centerline tool path
      (2) Edit tool path data to change possible variables
      (3) Calculate time to machine
      (4) Define tool selections and operating parameters
      (5) Filter tool path data to reduce size and time
      (6) Define materials stock
      (7) Change feed rates and compare results
      (8) Create set-up document
   b. Cut part as solid model
   c. Process Tool Path Data to Numerical Control Code
      (1) Select post processing file relative to machine tool being used
      (2) Execute post processing function
      (3) Edit numerical control program if needed
   d. Describe and Execute Post-Processor or Co-processor Functions

## COURSE OBJECTIVES: SCANS COMPETENCIES

*The Secretary's Commission on Achieving Necessary Skills (SCANS), U.S. Department of Labor, has identified in its "AMERICA 2000 REPORT" that all students should develop a new set of competencies and foundation skills if they are to enjoy a productive, full and satisfying life. These are in addition to the Technical Workplace Competencies required by industry. SCANS is made up of five competencies and a three-part foundation of skills and personal qualities that are needed for solid job performance.*

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The following activities will be performed by each student for successful completion of this course:

I. **COMPETENCIES**

*A.* ***Resources:*** *Identifies, organizes, plans, and allocates resources*
   1. follows a schedule to complete assigned tasks on time
   2. determine the initial cost of materials and "value added" as result of machining
   3. provide a self-evaluation of performance based on the time and quality of work

*B.* ***Interpersonal:*** *Works with others*
   1. complete assigned responsibilities within the shop floor serving as a member of the team
   2. provide individual assistance/direction to peers as requested
   3. produce machine parts to acceptable levels of quality as required
   4. works well with all members of the class

*C.* ***Information:*** *Acquires and uses information*
   1. read and interpret blueprints
   2. organize and apply theories of machine tool operation

*D.* ***Systems:*** *Understands complex inter-relationships*

1. demonstrate knowledge of the following systems:
   a. laboratory organization structure: physical and social
   b. organization of personnel and facilities on the shop floor
   c. systematic approach to the metal removal process
   d. dimensioning and measurement systems
   e. systematic organization of training materials
2. monitors and corrects performance during
   a. the machining process
   b. adjustments of individual laboratory work schedule
   c. constantly evaluating the quality of work to achieve acceptable standards
   d. maintains record of evaluations and sets individual goals

*E.* ***Technology:*** *Works with a variety of technologies*

1. chooses procedure, tools and equipment required to produce a part
2. applies appropriate procedures and uses appropriate tools and equipment to produce a machined part to acceptable standards
3. maintains and troubleshoots equipment
   a. applies appropriate preventative maintenance
   b. when operating machines
   c. reports all malfunctions of equipment to supervisor/instructor
   d. perform clean-up assignments of machine and shop floor at the end of the laboratory

## II. FOUNDATION SKILLS

*A.* ***Basic Skills:*** *Reads, writes, performs arithmetic and mathematical operations, listens and speaks.*

*1.* ***Reading:*** *Locates, understands, and interprets written information in prose and in documents such as manuals, graphs, and schedules*
   a. studies student laboratory manual
   b. interprets blueprints and technical drawings
   c. read/studies textbook
   d. follow a daily laboratory schedule to maintain appropriate time-line and product completion

*2.* ***Writing:*** *Communicates thoughts, ideas, information, and messages in writing; and creates documents such as letters, directions, manuals, reports, graphs, and flow charts*
   a. outline the steps necessary to produce a simple machine part
   b. maintain a lecture notebook
   c. submit written responses to chapter question assignments
   d. complete all written assignments

*3.* ***Arithmetic/Mathematics:*** *Perform basic computations and approaches practical problems by choosing appropriately from a variety of mathematical techniques*
   a. determines optimum machining speeds, feeds, and depth of cut
   b. calculates "value added to the part"
   c. aligns machine and/or work holding device
   d. taps and threads

e. keeps a running computation of individual grade
f. interconverts fractions to decimal expressions
g. use protractors to lay-out angle machining
h. use trigonometry to solve angle and taper calculations

4. ***Listening:*** *Receives, attends to, interprets, and responds to verbal messages and other cues*
   a. assimilate classroom instruction
   b. interpret and assimilate video instruction
   c. observe laboratory demonstrations
   d. seek and receive individualized instruction in the laboratory
5. ***Speaking:*** *Organizes ideas and communicates orally*
   a. participates in classroom discussions
   b. organize ideas and communicate specific questions to the instructor
   c. verbally affirms understanding of a concept, procedure, or required skill
   d. communicates with peers to ensure the smooth and safe operation of the laboratory

B. ***Thinking Skills:*** *Thinks creatively, makes decisions, solves problems, visualizes, knows how to learn and reasons.*

1. ***Decision Making:*** *Specifies goals and constraints, generates alternatives, considers risks, and evaluates and chooses best alternative*
   a. identifies personal goals
   b. identifies actions required to accomplish personal goals
2. ***Problem Solving:*** *Recognizes problems and devises and implements plan of action*
   a. makes daily accommodations to stay on schedule
   b. seeks additional instruction/clarification for assignment completion
   c. balances social and academic life/responsibilities
   d. accepts responsibility
3. ***Seeing Things In the Mind's Eye:*** *Organizes, and processes symbols, pictures, graphs, objects, and other information*
   a. interprets technical drawings
   b. interprets technical illustrations and symbols
   c. understands both written and verbal instructions
   d. assimilates process during instructor demonstrations
4. ***Knowing How to Learn:*** *Use efficient learning techniques to acquire and apply new knowledge and skills*
   a. demonstrate mastery of the basic skills and techniques
   b. use these sequential skills to support mastery of new skills
   c. understand the sequential nature of acquired skills and the subsequent knowledge application of new skills and techniques
5. ***Reasoning:*** *Discovers a rule or principle underlying the relationship between two or more objects and applies it when solving a problem*
   a. understands that practice may not make it perfect but it certainly will improve the skill of the operator
   b. understands that the quality of the product is a function of the time of the operation and the attitude and skill of the machinist

c. understands the relationship between different metals and the tool applied to the metal surface and adjusts machining parameters accordingly

C. ***Personal Qualities:*** Displays responsibility, self-esteem, sociability, self-management, and integrity and honesty.

1. ***Responsibility:*** *Exerts a high level of effort and perseveres towards goal attainment*
   a. develops an understanding that in order to be successful you must be a "good" student
   b. develops an understanding that a "good" student is the one who is prompt to every class and has prepared for the day's work
   c. develops an understanding good students know what they are going to do in class and does not waste time
   d. develops a fine work-ethic
2. ***Self-Esteem:*** *Believes in own self-worth and maintains a positive view of self*
   a. learns to take pride in his or her work through positive reinforcement
   b. sees himself or herself as an asset to the class through continued contributions to the group and a shared common goal
   c. understands that an individual with a positive attitude and the belief in their own abilities will systematically seek solutions and be a valuable employee
3. ***Sociability:*** *Demonstrates understanding, friendliness, adaptability, empathy, and politeness in group settings*
   a. assist classmates in improving technical skills
   b. assist students with special needs as a peer mentor
   c. share laboratory resources (machines, tools and instructor's individual attention)
4. ***Self-Management:*** *Assesses self accurately, sets personal goals, monitors progress, and exhibits self-control*
   a. perform in-process quality checks on machined parts
   b. maintain a record of academic achievement (individual grade book)
   c. make accommodations to laboratory schedules due to broken machines/tools
   d. accept the responsibility for self-management
5. ***Integrity/Honesty:*** *Chooses ethical courses of action*
   a. accept the responsibility for own actions
   b. exhibit personal honesty at all times
   c. accept the challenge of doing your own work in the laboratory, during examination, and on outside assignments
   d. understand the consequences of unethical behaviors

*Machine Tool Advanced Skills Technology Program*

MAST

# COURSE SYLLABUS

# INTRODUCTION TO CNC CONTROLLED VERTICAL MACHINING AND ELECTRONIC DISCHARGE MACHINING (E.D.M.)

# MAST PROGRAM
## COURSE SYLLABUS
## INTRODUCTION TO CNC CONTROLLED VERTICAL MACHINING & ELECTRONIC DISCHARGE MACHINING (E.D.M.)

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**Lecture hours/week: 3** **Lab hours/week: 3** **Credit hours: 4**

**COURSE DESCRIPTION:**

Theory of CNC Vertical machining techniques. Emphasis placed on basic operations of Vertical Machining, and EDM. Students in this class are expected to have previous Machining experience. (FT) Transfer Credit: CSU

**PREREQUISITES:** **Concurrent enrollment, or completion with a "C" or above, in Introduction to CNC and EDM**

**COURSE OBJECTIVES:**

Each student successfully completing this course will:

1. Identify CNC Mills and their controls and accessories
2. Use charts, reference tables, math calculations to determine speeds and feeds
3. Demonstrate the proper set up procedures for the Anilam, Bridgeport, and Fadal
4. Demonstrate proper use of Controller to set offsets, edit programs, and create programs at the Controller
5. Demonstrate a basic understanding of the common "G" & "M" codes as used on CNC machines to create various programs
6. Complete assigned projects using required skills with hands-on instruction by the instructor
7. Demonstrate reading and writing skills to read and prepare required documents for course work
8. Demonstrate communication skills to interact successfully with members of working teams and instructor

**REQUIRED COURSE MATERIALS:**

**Textbooks:** Examples of appropriate textbooks include:
Technology of Machine Tools, 4th Edition, 1989
Fundamentals of Numerical Control, 1990
Computer Numerical Control:From Programming to Networking, 1994
Anilam Vertical Machining Program Manual, 1991
Fadal Programming Manual, 1992
Bridgeport Programming Manual, 1992

Greco Systems Manual, 1992
Hansvedt Operating Manual, 1988

**Hand Tools/Supplies:** Computer Diskettes

## METHOD OF INSTRUCTION

**Lecture:** Presentations will include:

1. Lecture with, or without, various audio-visual aids
2. Discussion, debate, and/or critique
3. Demonstration
4. Computer-assisted or other self-paced instruction
5. Field trips or field assignments
6. Laboratory assignments utilizing specifically planned instructional activities or "live" work

**Laboratory:** Laboratory will be a "hands-on" process.

**Writing Assignments:** Writing assignments include:

1. Completing assigned reports
2. Providing written answers to assigned questions
3. Performing arithmetic calculations as assigned
4. Maintaining a notebook of class assignments and activities
5. Completing a 500 word written report dealing with a subject related to this course

**Appropriate Outside Assignments:** Students are expected to spend a minimum of two hours outside of class in practice and preparation for each hour of theory in class. Appropriate assignments include:

1. Researching appropriate readings
2. Preparing research reports
3. Preparing writing assignments
4. Studying as needed to perform successfully in class

**Appropriate Assignments That Demonstrate Critical Thinking:**

1. Students will be required to demonstrate verification and communication of their own programs.
2. Students must estimate machining time involved in producing a programmed work piece.
3. Students will interpret blueprints to produce required machine parts to specifications in the time allowed.
4. Students will be required to demonstrate use of the basic DOS and windows commands of a personal computer.
5. Students will be required to verify and communicate supplied programs, and make corrections and recommendations for efficiency and safety.

**Method of Evaluation:** A student's grade will be based on multiple measures of performance. The assessment will measure development of independent critical thinking skills and will include evaluation of the student's ability to:

1. perform the manipulative skills of the craft as required to satisfactorily complete laboratory assignments
2. apply theory to laboratory assignments
3. satisfactorily perform on written, oral, or practical examinations
4. satisfactorily perform on outside assignments including writing assignments
5. contribute to class discussions
6. maintain attendance per current policy
7. follow all laboratory rules and safety regulations

**LECTURE OUTLINE:**

| Lecture Topics | Text Reference Page | Contact Hrs. |
|---|---|---|
| **CNC Vertical Machining** | | |
| A. History | | |
| B. Theory of operation | | |
| C. Nomenclature | | |
| D. Safety | | |
| E. Controller commands | | |
| F. Discussion of "canned cycles" | | |
| G. Tooling setup | | |
| H. Tooling offsets | | |
| I. Editing programs | | |
| **Controls** | | |
| A. Anilam control | | |
| B. Bridgeport control | | |
| C. Fadal control | | |
| D. Greco System for creating programs | | |
| E. Hansvedt Control Panel | | |
| **Electronic Discharge Machining** | | |
| A. History | | |
| B. Theory of operation | | |
| C. Nomenclature | | |
| D. Safety | | |
| E. Controller settings | | |
| F. Tooling setup | | |
| G. Tooling materials | | |
| | **Total Lecture Hours** | — |

**LAB OUTLINE:**

| Lab Topics | Contact Hrs. |
|---|---|
| **CNC Vertical Machining** | |
| A. History | |
| B. Theory of operation | |
| C. Nomenclature | |
| D. Safety | |
| E. Controller commands | |

F. Discussion of "canned cycles"
G. Tooling setup
H. Tooling offsets
I. Editing programs

**Controls**

A. Anilam control
B. Bridgeport control
C. Fadal control
D. Greco System for creating programs
E. Hansvedt Control Panel

**Electronic Discharge Machining**

A. History
B. Theory of operation
C. Nomenclature
D. Safety
E. Controller settings
F. Tooling setup
G. Tooling materials

**Total Lab Hours** —

## COURSE OBJECTIVES: TECHNICAL COMPETENCIES

After the successful completion of this course the student will be able to:

**A. DESCRIBE VERTICAL MACHINING PROCESS AND SAFETY**

1. Describe History of Vertical Machining
   a. Describe proper use of various machines
2. Describe Theory of Operation
   a. Describe open and closed loop systems
   b. Describe various oil and air requirements
   c. Describe how vertical machines function
3. Describe Nomenclature Used in Vertical Machining
   a. Describe common tools used to:
      (1) Mill
      (2) Single point thread
      (3) Drill
      (4) Single point bore
      (5) Tap
      (6) Reaming
   b. Describe solid and collet type tool holders
4. Demonstrate Safety Practices Related to Vertical Machining Centers
   a. Demonstrate operating safety practices, including:
      (1) Safety door interlocks
      (2) Machining vise loading and unloading
      (3) Power box interlocks
      (4) Machine coolant disposal
      (5) Tool loading and unloading
   b. Describe/Identify personal safety equipment

**B. DESCRIBE VERTICAL MACHINING FUNCTIONS**

1. Describe Controller Functions, including:
   - a. Power meter
   - b. Automatic mode
   - c. Key lock
   - d. Emergency stop button
   - e. Option switches
   - f. Manual modes:
     - (1) Command mode
     - (2) MDI mode
   - g. Rapid travel over ride
   - h. Single step mode (Block-To-Block)
   - i. Feed rate override
   - j. Jog mode
   - k. Spindle speed override
   - l. Spindle On/Off
   - m. Axis selector
   - n. Slide hold
   - o. Increment of movement selector
   - p. Coolant 1 and 2 On/Off
   - q. Tool In/Out
   - r. Start button
   - s. Turret clockwise (CW) and turret counterclockwise (CCW)
   - t. Start function

**C. SET-UP AND PROGRAM OPERATION OF VERTICAL MACHINE**

1. Describe Machine Tool Limitations, including:
   - a. Number of possible tools
   - b. Limits in X,Y and Z axes
   - c. Maximum spindle speed and horsepower
   - d. Memory size in controller
   - e. Fast feed rate
   - f. Oil and air requirements
   - g. Rapid positioning rate
   - h. Communication systems
2. Perform Basic Machine Set-Up
   - a. Check Oil and Air Supply
   - b. Set tool changer numbers
   - c. Turn power on
   - d. Mount machine vise on machine table
   - e. Set machine home position
   - f. Indicate vise to within specified tolerances
   - g. Load tools into proper tool holders
   - h. Load part into vise
   - i. Load tools into tool carousel
     - (1) Load tools using spindle
     - (2) Load tools directly into carousel
3. Set Part Home
   - a. Set part home using edge finder

b. Set part home using test indicator and gauge block
c. Set part home from tooling ball using fixture offsets

4. Set Tool Length Offsets
   a. Set tool length offsets using workpiece
   b. Set tool length offsets using gauge block
   c. Set tool length offsets using electronic probe
   d. Set tool length offsets using keyboard commands, including:
      (1) Set-Length (SL) command
      (2) Utility (UT) option
   e. Modify length and diameter offsets using tool page editor.
   f. Modify length and diameter offsets using keyboard and SL command
   g. Upload and download tool information to storage
5. Load Program
   a. Upload and download programs using RS-232 interface
   b. Upload and download programs using local area network (Greco System)
6. Edit Program for Machine Tool
   a. Edit program at machine tool using editor in controller
   b. Edit program using DOS and Windows editors
7. Create Program at Machine Tool for Common Machine Operations
   a. Use machine controller
   b. Use DOS editor
   c. Use Windows editor

**D. DEMONSTRATE MACHINING OF OBJECTS ON VERTICAL MACHINING CENTER**

1. Machine Objects, including:
   a. Outside Contours
   b. Pockets
   c. Drill and tapped holes
   d. Single point boring
   e. Reaming
   f. Single point thread internal and external
2. Set-Up 3 Dimensional Digitizer and Machine Model
   a. Mount model on machine table
   b. Install 3-Dimensional Digitizing unit
   c. Establish communications with computer
   d. Define grid pattern and feed rate required for given tolerances
   e. Set part home
   f. Digitize model
   g. Process digital data for machining
   h. Machine new model with program created from digitizer
3. Create Workpiece Using 4th and 5th Axes
   a. Mount, connect and indicate 4th and 5th axes attachment
   b. Set-tooling
   c. Machine workpiece
   d. Remove 4th and 5th axes attachment
4. Maintain Vertical Machine
   a. Mix coolant
   b. Determine need for coolant change

c. Change coolant
d. Clean coolant tank
e. Clean machine
f. Change oil filters
g. Add lubricating fluid
h. Add hydraulic fluid
i. Dispose of coolant and oils per EPA regulations

**E. PERFORM ADVANCE EDM OPERATIONS**

1. Review Use of Sinker or "Ram" Type EDM
   a. Identify parts of machine
   b. Describe various applications suited for RAM type EDM
   c. Describe reasons for choosing EDM over traditional machining
   d. Describe and list materials used for "cutting tools" electrodes
   e. Describe dialectric liquids and their application
2. Demonstrate Safety Practices Related to EDM
   a. Demonstrate operating safety practices
   b. Describe/Identify personal safety equipment
3. Program Sinker or "Ram" Type to Create Mold
   a. Adjust power supply setting
   b. Adjust feed setting
   c. Identify and apply work holding devices
   d. Mount electrode in machine tool
   e. Locate workpiece in correct position
   f. Set stops for proper depth
   g. Adjust power and feed settings for required dimensional and surface tolerances
4. Machine Work with EDM
   a. Machine workpiece to rough condition
   b. Machine workpiece to finish specifications
   c. Inspect project
   d. Turn off machine
   e. Dismount project
5. Perform Preventive Maintenance
   a. Clean machines
   b. Change filters
   c. Determine need to change dialectric fluid
   d. Change dialectric fluid
   e. Dispose of coolant and oils per EPA regulations

## COURSE OBJECTIVES: SCANS COMPETENCIES

*The Secretary's Commission on Achieving Necessary Skills (SCANS), U.S. Department of Labor, has identified in its "AMERICA 2000 REPORT" that all students should develop a new set of competencies and foundation skills if they are to enjoy a productive, full and satisfying life. These are in addition to the Technical Workplace Competencies required by industry. SCANS is made up of five competencies and a three-part foundation of skills and personal qualities that are needed for solid job performance.*

The following activities will be performed by each student for successful completion of this course:

## I. COMPETENCIES

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1. follows a schedule to complete assigned tasks on time
2. determine the initial cost of materials and "value added" as result of machining
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1. read and interpret blueprints
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1. demonstrate knowledge of the following systems:
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   b. sees himself or herself as an asset to the class through continued contributions to the group and a shared common goal
   c. understands that an individual with a positive attitude and the belief in their own abilities will systematically seek solutions and be a valuable employee
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   a. assist classmates in improving technical skills
   b. assist students with special needs as a peer mentor

c. share laboratory resources (machines, tools and instructor's individual attention)

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   a. perform in-process quality checks on machined parts
   b. maintain a record of academic achievement (individual grade book)
   c. make accommodations to laboratory schedules due to broken machines/tools
   d. accept the responsibility for self-management

5. ***Integrity/Honesty:*** *Chooses ethical courses of action*
   a. accept the responsibility for own actions
   b. exhibit personal honesty at all times
   c. accept the challenge of doing your own work in the laboratory, during examination, and on outside assignments
   d. understand the consequences of unethical behaviors

MACT170
05/081596

*M*achine Tool *A*dvanced *S*kills
*T*echnology Program

MAST

# COURSE SYLLABUS

# APPLICATION OF CNC CONTROLLED VERTICAL MACHINING AND ELECTRONIC DISCHARGE MACHINING (E.D.M.)

# MAST PROGRAM
## COURSE SYLLABUS
## APPLICATION OF CNC CONTROLLED VERTICAL MACHINING & ELECTRONIC DISCHARGE MACHINING (E.D.M.) I

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**Lecture hours/week: 0** **Lab hours/week: 6** **Credit hours: 2**

**COURSE DESCRIPTION:**

Exercises in CNC Vertical machining techniques and EDM at an intermediate level. This class is to allow students the opportunity to gain speed and efficiency in a hands on environment. Students in this class are expected to have previous machining experience. (FT) Transfer Credit: CSU.

**PREREQUISITES:** **Concurrent enrollment, or completion with "C" or above, in Introduction to CNC Controlled Vertical Machining and EDM**

**COURSE OBJECTIVES:**

Each student successfully completing this course will:

1. Use verification software to analyze the effects of speeds and feeds, depth of cut and total volume of material removed with intermediate level of quality and quantity of projects.
2. Demonstrate the proper set up procedures for the Anilam, Bridgeport, and Fadal using fixture offsets, multiple vises and TS-20 probe.
3. Demonstrate proper use of Controller to set offsets, edit programs, and create programs at the Controller with intermediate level of quality and quantity of projects.
4. Demonstrate a basic understanding of the common "G" & "M" codes as used on CNC machines to create various programs.
5. Complete assigned projects using required skills with limited hands-on instruction by the instructor.
6. Demonstrate reading and writing skills to read and prepare required documents for course work.
7. Demonstrate communication skills to interact successfully with members of working teams and instructor.

**REQUIRED COURSE MATERIALS:**

**Textbooks:** Examples of appropriate textbooks include:
Technology of Machine Tools, 4th Edition, 1989
Fundamentals of Numerical Control, W. Luggen, 1990
Computer Numerical Control: From Programming to Networking, 1994
Anilam Vertical Machining Program Manual, 1991

Fadal Programming Manual, 1992
Bridgeport Programming Manual, 1992
Greco Systems Manual, 1992
Hansvedt Operating Manual, 1988

**Hand Tools/Supplies:** Computer Diskettes

**METHOD OF INSTRUCTION:**

**Lecture:** Presentations will include:

1. Lecture with, or without, various audio-visual aids
2. Discussion, debate, and/or critique
3. Demonstration
4. Computer-assisted or other self-paced instruction
5. Field trips or field assignments
6. Laboratory assignments utilizing specifically planned instructional activities or "live" work

**Laboratory:** Laboratory will be a "hands-on" process.

**Writing Assignments:** Writing assignments include:

1. Completing assigned reports
2. Providing written answers to assigned questions
3. Performing arithmetic calculations as assigned
4. Maintaining a notebook of class assignments and activities
5. Completing a 500 word written report dealing with a subject related to this course

**Appropriate Outside Assignments:** Students are expected to spend a minimum of two hours outside of class in practice and preparation for each hour in class. Appropriate assignments include:

1. Researching appropriate readings
2. Preparing research reports
3. Preparing writing assignments
4. Studying as needed to perform successfully in class

**Appropriate Assignments That Demonstrate Critical Thinking:**

1. Students will be required to demonstrate verification and communication of their own programs.
2. Students will be required to demonstrate machining a work piece from their own program.
3. Students must estimate machining time involved in producing a programmed work piece.
4. Students will interpret blueprints to produce required machine parts to specifications in the time allowed.
5. Students will be required to demonstrate use of the basic DOS and windows commands of a personal computer.
6. Students will be required to verify and communicate supplied programs, and make corrections and recommendations for efficiency and safety.

**Method of Evaluation:** A student's grade will be based on multiple measures of performance. The assessment will measure development of independent critical thinking skills and will include evaluation of the student's ability to:

1. perform the manipulative skills of the craft as required to satisfactorily complete laboratory assignments
2. apply theory to laboratory assignments
3. satisfactorily perform on written, oral, or practical examinations
4. satisfactorily perform on outside assignments including writing assignments
5. contribute to class discussions
6. maintain attendance per current policy
7. follow all laboratory rules and safety regulations

**LAB OUTLINE:**

| Lab Topics | Contact Hrs. |
|---|---|
| **CNC Vertical Machining** | |
| A. History | |
| B. Theory of operation | |
| C. Nomenclature | |
| D. Safety | |
| E. Controller commands | |
| F. Discussion of "canned cycles" | |
| G. Tooling setup | |
| H. Tooling offsets | |
| I. Editing programs | |
| **Controls** | |
| A. Anilam Control | |
| B. Bridgeport Control | |
| C. Fadal Control | |
| D. Greco System for creating programs | |
| **Electronic Discharge Machining** | |
| A. History | |
| B. Theory of operation | |
| C. Nomenclature | |
| D. Safety | |
| E. Controller settings | |
| F. Tooling setup | |
| G. Tooling materials | |
| **Total Lab Hours** | — |

**COURSE OBJECTIVES: TECHNICAL COMPETENCIES**

After the successful completion of this course the student will be able to:

**A. SET-UP AND PROGRAM OPERATION OF VERTICAL MACHINE**

1. Determine and Set Machine Tool Operations, including:
   a. Number of tools required
   b. Limits in X,Y and Z axes

c. Spindle speed and horsepower
d. Memory size in controller
e. Fast feed rate
f. Oil and air requirements
g. Rapid positioning rate
h. Communication systems

2. Perform Basic Machine Set-Up
   a. Check Oil and Air Supply
   b. Set tool changer numbers
   c. Turn power on
   d. Mount machine vise on machine table
   e. Set machine home position
   f. Indicate vise to within specified tolerances
   g. Load tools into proper tool holders
   h. Load part into vise
   i. Load tools into tool carousel
      (1) Load tools using spindle
      (2) Load tools directly into carousel
3. Set Part Home
   a. Set part home using edge finder
   b. Set part home using test indicator and gauge block
   c. Set part home from tooling ball using fixture offsets
4. Set Tool Length Offsets
   a. Set tool length offsets using workpiece
   b. Set tool length offsets using gauge block
   c. Set tool length offsets using electronic probe
   d. Set tool length offsets using keyboard commands, including:
      (1) Set-Length (SL) command
      (2) Utility (UT) option
   e. Modify length and diameter offsets using tool page editor.
   f. Modify length and diameter offsets using keyboard and SL command
   g. Upload and download tool information to storage
5. Load Program
   a. Upload and download programs using RS-232 interface
   b. Upload and download programs using local area network (Greco System)
6. Edit Program for Machine Tool
   a. Edit program at machine tool using editor in controller
   b. Edit program using DOS and Windows editors
7. Create Program at Machine Tool for Common Machine Operations
   a. Use machine controller
   b. Use DOS editor
   c. Use Windows editor

**B. DEMONSTRATE MACHINING OF OBJECTS ON VERTICAL MACHINING CENTER**

1. Demonstrate Safety Practices Related to Vertical Machining
   a. Demonstrate operating safety practices
   b. Describe/Identify personal safety equipment

2. Machine Objects with Intermediate Level Quality and Quantity of Projects, including:
   a. Outside Contours
   b. Pockets
   c. Drill and tapped holes
   d. Single point boring
   e. Reaming
   f. Single point thread internal and external
3. Set-Up 3 Dimensional Digitizer and Machine Model with Intermediate Level Quality and Quantity of Projects:
   a. Mount model on machine table
   b. Install 3-Dimensional Digitizing unit
   c. Establish communications with computer
   d. Define grid pattern and feed rate required for given tolerances
   e. Set part home
   f. Digitize model
   g. Process digital data for machining
   h. Machine new model with program created from digitizer
4. Create Workpiece Using 4th and 5th Axes with Intermediate Level Quality and Quantity of Projects:
   a. Mount, connect and indicate 4th and 5th axes attachment
   b. Set-tooling
   c. Machine workpiece
   d. Remove 4th and 5th axes attachment
5. Maintain Vertical Machine
   a. Mix coolant
   b. Determine need for coolant change
   c. Change coolant
   d. Clean coolant tank
   e. Clean machine
   f. Change oil filters
   g. Add lubricating fluid
   h. Add hydraulic fluid
   i. Dispose of coolant and oils per EPA regulations

**C. PERFORM ADVANCE EDM OPERATIONS**

1. Program Sinker or "Ram" Type to Create Mold with Intermediate Level Quality and Quantity of Projects:
   a. Adjust power supply setting
   b. Adjust feed setting
   c. Identify and apply work holding devices
   d. Mount electrode in machine tool
   e. Locate workpiece in correct position
   f. Set stops for proper depth
   g. Adjust power and feed settings for required dimensional and surface tolerances
2. Demonstrate Safety Practices Related to EDM
   a. Demonstrate operating safety practices
   b. Describe/Identify personal safety equipment

3. Machine Work with EDM with Intermediate Level Quality and Quantity of Projects:
    a. Machine workpiece to rough condition
    b. Machine workpiece to finish specifications
    c. Inspect project
    d. Turn off machine
    e. Dismount project
4. Perform Preventive Maintenance
    a. Clean machines
    b. Change filters
    c. Determine need to change dielectric fluid
    d. Change dielectric fluid
    e. Dispose of coolant and oils per EPA regulations

## COURSE OBJECTIVES: SCANS COMPETENCIES

*The Secretary's Commission on Achieving Necessary Skills (SCANS), U.S. Department of Labor, has identified in its "AMERICA 2000 REPORT" that all students should develop a new set of competencies and foundation skills if they are to enjoy a productive, full and satisfying life. These are in addition to the Technical Workplace Competencies required by industry. SCANS is made up of five competencies and a three-part foundation of skills and personal qualities that are needed for solid job performance.*

---

The following activities will be performed by each student for successful completion of this course:

**I. COMPETENCIES**

*A.* ***Resources:*** *Identifies, organizes, plans, and allocates resources*
1. follows a schedule to complete assigned tasks on time
2. determine the initial cost of materials and "value added" as result of machining
3. provide a self-evaluation of performance based on the time and quality of work

*B.* ***Interpersonal:*** *Works with others*
1. complete assigned responsibilities within the shop floor serving as a member of the team
2. provide individual assistance/direction to peers as requested
3. produce machine parts to acceptable levels of quality as required
4. works well with all members of the class

*C.* ***Information:*** *Acquires and uses information*
1. read and interpret blueprints
2. organize and apply theories of machine tool operation

*D.* ***Systems:*** *Understands complex inter-relationships*
1. demonstrate knowledge of the following systems:
    a. laboratory organization structure: physical and social
    b. organization of personnel and facilities on the shop floor

c. systematic approach to the metal removal process
d. dimensioning and measurement systems
e. systematic organization of training materials

2. monitors and corrects performance during
   a. the machining process
   b. adjustments of individual laboratory work schedule
   c. constantly evaluating the quality of work to achieve acceptable standards
   d. maintains record of evaluations and sets individual goals

*E.* ***Technology:*** *Works with a variety of technologies*

1. chooses procedure, tools and equipment required to produce a part
2. applies appropriate procedures and uses appropriate tools and equipment to produce a machined part to acceptable standards
3. maintains and troubleshoots equipment
   a. applies appropriate preventative maintenance
   b. when operating machines
   c. reports all malfunctions of equipment to supervisor/instructor
   d. perform clean-up assignments of machine and shop floor at the end of the laboratory

## II. FOUNDATION SKILLS

*A.* ***Basic Skills:*** *Reads, writes, performs arithmetic and mathematical operations, listens and speaks.*

*1.* ***Reading:*** *Locates, understands, and interprets written information in prose and in documents such as manuals, graphs, and schedules*
   a. studies student laboratory manual
   b. interprets blueprints and technical drawings
   c. read/studies textbook
   d. follow a daily laboratory schedule to maintain appropriate time-line and product completion

*2.* ***Writing:*** *Communicates thoughts, ideas, information, and messages in writing; and creates documents such as letters, directions, manuals, reports, graphs, and flow charts*
   a. outline the steps necessary to produce a simple machine part
   b. maintain a lecture notebook
   c. submit written responses to chapter question assignments
   d. complete all written assignments

*3.* ***Arithmetic/Mathematics:*** *Perform basic computations and approaches practical problems by choosing appropriately from a variety of mathematical techniques*
   a. determines optimum machining speeds, feeds, and depth of cut
   b. calculates "value added to the part"
   c. aligns machine and/or work holding device
   d. taps and threads
   e. keeps a running computation of individual grade
   f. interconverts fractions to decimal expressions
   g. use protractors to lay-out angle machining
   h. use trigonometry to solve angle and taper calculations

4. ***Listening:*** *Receives, attends to, interprets, and responds to verbal messages and other cues*
    a. assimilate classroom instruction
    b. interpret and assimilate video instruction
    c. observe laboratory demonstrations
    d. seek and receive individualized instruction in the laboratory
5. ***Speaking:*** *Organizes ideas and communicates orally*
    a. participates in classroom discussions
    b. organize ideas and communicate specific questions to the instructor
    c. verbally affirms understanding of a concept, procedure, or required skill
    d. communicates with peers to ensure the smooth and safe operation of the laboratory

B. ***Thinking Skills:*** *Thinks creatively, makes decisions, solves problems, visualizes, knows how to learn and reasons.*
1. ***Decision Making:*** *Specifies goals and constraints, generates alternatives, considers risks, and evaluates and chooses best alternative*
    a. identifies personal goals
    b. identifies actions required to accomplish personal goals
2. ***Problem Solving:*** *Recognizes problems and devises and implements plan of action*
    a. makes daily accommodations to stay on schedule
    b. seeks additional instruction/clarification for assignment completion
    c. balances social and academic life/responsibilities
    d. accepts responsibility
3. ***Seeing Things In the Mind's Eye:*** *Organizes, and processes symbols, pictures, graphs, objects, and other information*
    a. interprets technical drawings
    b. interprets technical illustrations and symbols
    c. understands both written and verbal instructions
    d. assimilates process during instructor demonstrations
4. ***Knowing How to Learn:*** *Use efficient learning techniques to acquire and apply new knowledge and skills*
    a. demonstrate mastery of the basic skills and techniques
    b. use these sequential skills to support mastery of new skills
    c. understand the sequential nature of acquired skills and the subsequent knowledge application of new skills and techniques
5. ***Reasoning:*** *Discovers a rule or principle underlying the relationship between two or more objects and applies it when solving a problem*
    a. understands that practice may not make it perfect but it certainly will improve the skill of the operator
    b. understands that the quality of the product is a function of the time of the operation and the attitude and skill of the machinist
    c. understands the relationship between different metals and the tool applied to the metal surface and adjusts machining parameters accordingly

C. ***Personal Qualities:*** *Displays responsibility, self-esteem, sociability, self-management, and integrity and honesty.*

1. ***Responsibility:*** *Exerts a high level of effort and perseveres towards goal attainment*
   a. develops an understanding that in order to be successful you must be a "good" student
   b. develops an understanding that a "good" student is the one who is prompt to every class and has prepared for the day's work
   c. develops an understanding good students know what they are going to do in class and does not waste time
   d. develops a fine work-ethic
2. ***Self-Esteem:*** *Believes in own self-worth and maintains a positive view of self*
   a. learns to take pride in his or her work through positive reinforcement
   b. sees himself or herself as an asset to the class through continued contributions to the group and a shared common goal
   c. understands that an individual with a positive attitude and the belief in their own abilities will systematically seek solutions and be a valuable employee
3. ***Sociability:*** *Demonstrates understanding, friendliness, adaptability, empathy, and politeness in group settings*
   a. assist classmates in improving technical skills
   b. assist students with special needs as a peer mentor
   c. share laboratory resources (machines, tools and instructor's individual attention)
4. ***Self-Management:*** *Assesses self accurately, sets personal goals, monitors progress, and exhibits self-control*
   a. perform in-process quality checks on machined parts
   b. maintain a record of academic achievement (individual grade book)
   c. make accommodations to laboratory schedules due to broken machines/tools
   d. accept the responsibility for self-management
5. ***Integrity/Honesty:*** *Chooses ethical courses of action*
   a. accept the responsibility for own actions
   b. exhibit personal honesty at all times
   c. accept the challenge of doing your own work in the laboratory, during examination, and on outside assignments
   d. understand the consequences of unethical behaviors

***M*achine Tool *A*dvanced *S*kills**
***T*echnology Program**

# MAST

## COURSE SYLLABUS

## ADVANCED CAD/CAM

# MAST PROGRAM
## COURSE SYLLABUS
## ADVANCED CAD/CAM

**Lecture hours/week: 3** **Lab hours/week: 3** **Credit hours: 4**

**COURSE DESCRIPTION:**

Advanced CAD/CAM theory and software. The emphasis will be on the generation of CNC programs, using advanced modeling techniques for both CNC Mill and CNC Lathe. (FT) Transfer Credit: CSU

**PREREQUISITES:** **Completion of Introduction to CAD/CAM with "C" or above**

**COURSE OBJECTIVES:**

Each student successfully completing this course will:

1. Use verification software to analyze the effects of speeds, feeds and depth of cut and total volume of material removal.
2. Demonstrate the correct use of CAD/CAM software to create 2 and 3 basic dimensional geometric shapes and surface models.
3. Demonstrate the ability to modify post-processor and co-processor data files.
4. Properly identify various parts of CNC program generation.
5. Perform editing of CNC programs using various software.
6. Demonstrate use of communications module within CAD/CAM software.
7. Demonstrate an understanding of the use of multiple tool planes and multi-axis machining.
8. Demonstrate proper use of personal computers for routine maintenance of systems..
9. Demonstrate a basic understanding of the common DOS and Windows commands as used on personal computers.
10. Demonstrate reading and writing skills to read and prepare required documents for course work.
11. Demonstrate communication skills to interact successfully with members of working teams and instructor.

**REQUIRED COURSE MATERIALS:**

**Textbooks:** Examples of appropriate textbooks include:

**MasterCam For Windows**, 1995
**SmartCam Programming Manuals**, 1992
**Anilam Vertical Machining Program Manual**, 1991
**Bendix Dynapath Manual**, 1989
**Fadal Programming Manual**, 1992
**Fanuc 6T Programming Manual**, 1988
**Greco System Manual**, 1992
**Vericut Programming Manual**, 1992

N-See Programming Manual, 1992
**Surfcam Programming Manual**, Current Edition

**Hand Tools/Supplies:** Computer Diskettes

**METHOD OF INSTRUCTION:**

**Lecture:** Presentations will include:

1. Lecture with, or without, various audio-visual aids
2. Discussion, debate, and/or critique
3. Demonstration
4. Computer-assisted or other self-paced instruction
5. Field trips or field assignments
6. Laboratory assignments utilizing specifically planned instructional activities or "live" work.

**Laboratory:** Laboratory will be a "hands-on" process.

**Writing Assignments:** Writing assignments include:

1. Completing assigned reports
2. Providing written answers to assigned questions
3. Performing arithmetic calculations as assigned
4. Maintaining a notebook of class assignments and activities
5. Completing a 500 word written report dealing with a subject related to this course.

**Appropriate Outside Assignments:** Students are expected to spend a minimum of two hours outside of class in practice and preparation for each hour of theory in class. Appropriate assignments include:

1. Researching appropriate readings
2. Preparing research reports
3. Preparing writing assignments
4. Studying as needed to perform successfully in class

**Appropriate Assignments That Demonstrate Critical Thinking**:

1. Students will be required to demonstrate verification and communication of their own programs.
2. Students must estimate machining time involved in producing a programmed work piece.
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4. Students will be required to demonstrate using the basic DOS and Windows commands of a personal computer.
5. Students will be required to verify and communicate supplied programs, and make corrections and recommendations for efficiency and safety.

**Method of Evaluation:** A student's grade will be based on multiple measures of performance. The assessment will measure development of independent critical thinking skills and will include evaluation of the student's ability to:

1. perform the manipulative skills of the craft as required to satisfactorily complete laboratory assignments
2. apply theory to laboratory assignments
3. satisfactorily perform on written, oral, or practical examinations
4. satisfactorily perform on outside assignments including writing assignments
5. contribute to class discussions
6. maintain attendance per current policy
7. follow all laboratory rules and safety regulations

**LECTURE OUTLINE:**

| Lecture Topics | Text Reference Page | Contact Hrs. |
|---|---|---|

**Basic Geometry Generation Review**

A. Contours
B. Pockets
C. Lettering
D. Drilling

**Basic Tool Paths Generation Review**

A. Contours
B. Pockets
C. Lettering
D. Drilling

**Advanced Geometries**

A. Ruled surfaces
B. Coons surface
C. Lofted surfaces
D. 3-d Swept surfaces

**Tooling Parameters**

A. Definition of materials
B. Definition of tool files
C. Discussion of speeds, and feeds
D. Discussion of cutting tools and geometries

**Intermediate Files**

A. Backplotting completed intermediate files
B. Editing intermediate files
C. Merging intermediate files
D. Projection of intermediate files

**Generating CNC Code**

A. Selection of post, or co-processors
B. Operation of post, or co-processors
C. Reverse postprocessing
D. Edit processors

**Communication parameters**

A. RS-232 interface

B. Downloading
C. Uploading
D. Handshaking
E. Greco System's communication

**Personal Computer Systems Requirements**

A. Basic terminology
B. Basic operation
C. Basic DOS commands

**Total Lecture Hours** —

**LAB OUTLINE:**

| Lab Topics | Contact Hrs. |
|---|---|

**Basic Geometry Generation Review**

A. Contours
B. Pockets
C. Lettering
D. Drilling

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**Personal Computer Systems Requirements**

A. Basic terminology
B. Basic operation
C. Basic DOS commands

**Total Lab Hours** —

## COURSE OBJECTIVES: TECHNICAL COMPETENCIES

After the successful completion of this course the student will be able to:

**A. CREATE DESIGNS WITH CAD SECTION OF CAD/CAM PROGRAM**

1. Create Advanced Geometric Surfaces
   a. Create advanced geometric surfaces to include:
      (1) Lofted / Cross Section
      (2) Blend
      (3) Swept / Drive Curve
      (4) Trim
      (5) Coons / 4-Curve
      (6) Draft
      (7) Offset
      (8) Nurb Surface
      (9) Fillet
      (10) Parametric Surface
2. Edit Basic Geometric Entities
   a. Modify and edit advanced geometric surfaces to include:
      (1) Trimming
      (2) Breaking
      (3) Joining
      (4) Fillet
3. Edit Advanced Geometric Surfaces
   a. Modify and edit advanced geometric surfaces to include:
      (1) Control points of nurbs
      (2) Conversion to nurbs entity
      (3) Extend entities
      (4) Drag entities
      (5) Edit entities
   b. Change cutter offset side
   c. Change cutting directions
   d. Turn surface normal arrows on and off
   e. Decompose composite surfaces
   f. Twist vectors of parametric surface
   g. Create polygons on surface
   h. Align surface normals
   i. Trim surfaces
   j. Untrim trimmed surfaces

4. Transform Geometric Entities using CAD Commands
    a. Scale X,Y, and Z at possible separate ratios
5. Execute Screen and Display Functions
    a. Use screen and display functions to:
        (1) Change surface density
        (2) Shade surface models
        (3) Blank and unblank entities

**B. PROCESS TOOL PATH DATA**

1. Generate Advanced Vertical Machining Code
    a. Generate Code for 3 axis surface machining to include:
        (1) Single surface machining, including roughing and finishing
        (2) Multiple surface machining, including roughing and finishing
    b. Generate code for 4 and 5 axis surface machining to include:
        (1) Single surface machining, including roughing and finishing
        (2) Multiple surface machining, including roughing and finishing
2. Import and Machine Scanned Data
    a. Import and machine 2 dimensional data
    b. Import and machine 3 dimensional data
3. Describe and Execute Post-Processor or Co-processor Functions
    a. Edit processors
4. Program Lathe or Turning Operations
    a. Use CAD section to create geometric designs
    b. Create lathe tools as required
5. Create Tool Path Information to Rough and Finish
    a. Create tool path information to rough and finish during:
        (1) Turning operations
        (2) Facing operations
        (3) Grooving operations
        (4) Internal boring operations / external boring operations
        (5) Internal and external threading

## COURSE OBJECTIVES: SCANS COMPETENCIES

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---

The following activities will be performed by each student for successful completion of this course:

**I. COMPETENCIES**

***A. Resources:*** *Identifies, organizes, plans, and allocates resources*

1. follows a schedule to complete assigned tasks on time

2. determine the initial cost of materials and "value added" as result of machining
3. provide a self-evaluation of performance based on the time and quality of work

*B.* ***Interpersonal:*** *Works with others*

1. complete assigned responsibilities within the shop floor serving as a member of the team
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*C.* ***Information:*** *Acquires and uses information*

1. read and interpret blueprints
2. organize and apply theories of machine tool operation

*D.* ***Systems:*** *Understands complex inter-relationships*

1. demonstrate knowledge of the following systems:
   a. laboratory organization structure: physical and social
   b. organization of personnel and facilities on the shop floor
   c. systematic approach to the metal removal process
   d. dimensioning and measurement systems
   e. systematic organization of training materials
2. monitors and corrects performance during
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   a. applies appropriate preventative maintenance
   b. when operating machines
   c. reports all malfunctions of equipment to supervisor/instructor
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## II. FOUNDATION SKILLS

*A.* ***Basic Skills:*** *Reads, writes, performs arithmetic and mathematical operations, listens and speaks.*

*1.* ***Reading:*** *Locates, understands, and interprets written information in prose and in documents such as manuals, graphs, and schedules*
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   b. interpret and assimilate video instruction
   c. observe laboratory demonstrations
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B. ***Thinking Skills:*** *Thinks creatively, makes decisions, solves problems, visualizes, knows how to learn and reasons.*
1. ***Decision Making:*** *Specifies goals and constraints, generates alternatives, considers risks, and evaluates and chooses best alternative*
   a. identifies personal goals
   b. identifies actions required to accomplish personal goals
2. ***Problem Solving:*** *Recognizes problems and devises and implements plan of action*
   a. makes daily accommodations to stay on schedule
   b. seeks additional instruction/clarification for assignment completion
   c. balances social and academic life/responsibilities
   d. accepts responsibility
3. ***Seeing Things In the Mind's Eye:*** *Organizes, and processes symbols, pictures, graphs, objects, and other information*
   a. interprets technical drawings
   b. interprets technical illustrations and symbols
   c. understands both written and verbal instructions

d. assimilates process during instructor demonstrations

4. ***Knowing How to Learn:*** *Use efficient learning techniques to acquire and apply new knowledge and skills*
   a. demonstrate mastery of the basic skills and techniques
   b. use these sequential skills to support mastery of new skills
   c. understand the sequential nature of acquired skills and the subsequent knowledge application of new skills and techniques

5. ***Reasoning:*** *Discovers a rule or principle underlying the relationship between two or more objects and applies it when solving a problem*
   a. understands that practice may not make it perfect but it certainly will improve the skill of the operator
   b. understands that the quality of the product is a function of the time of the operation and the attitude and skill of the machinist
   c. understands the relationship between different metals and the tool applied to the metal surface and adjusts machining parameters accordingly

C. ***Personal Qualities:*** *Displays responsibility, self-esteem, sociability, self-management, and integrity and honesty.*

1. ***Responsibility:*** *Exerts a high level of effort and perseveres towards goal attainment*
   a. develops an understanding that in order to be successful you must be a "good" student
   b. develops an understanding that a "good" student is the one who is prompt to every class and has prepared for the day's work
   c. develops an understanding good students know what they are going to do in class and does not waste time
   d. develops a fine work-ethic

2. ***Self-Esteem:*** *Believes in own self-worth and maintains a positive view of self*
   a. learns to take pride in his or her work through positive reinforcement
   b. sees himself or herself as an asset to the class through continued contributions to the group and a shared common goal
   c. understands that an individual with a positive attitude and the belief in their own abilities will systematically seek solutions and be a valuable employee

3. ***Sociability:*** *Demonstrates understanding, friendliness, adaptability, empathy, and politeness in group settings*
   a. assist classmates in improving technical skills
   b. assist students with special needs as a peer mentor
   c. share laboratory resources (machines, tools and instructor's individual attention)

4. ***Self-Management:*** *Assesses self accurately, sets personal goals, monitors progress, and exhibits self-control*
   a. perform in-process quality checks on machined parts
   b. maintain a record of academic achievement (individual grade book)
   c. make accommodations to laboratory schedules due to broken machines/tools

d. accept the responsibility for self-management

5. ***Integrity/Honesty:*** *Chooses ethical courses of action*
   a. accept the responsibility for own actions
   b. exhibit personal honesty at all times
   c. accept the challenge of doing your own work in the laboratory, during examination, and on outside assignments
   d. understand the consequences of unethical behaviors

MACT180
05/081596

*M*achine Tool *A*dvanced *S*kills
*T*echnology Program

# MAST

## COURSE SYLLABUS

## APPLICATION IN ADVANCED CAD/CAM I

# MAST PROGRAM
## COURSE SYLLABUS
## APPLICATION IN ADVANCED CAD/CAM I

**Lecture hours/week: 0** **Lab hours/week: 6** **Credit hours: 2**

**COURSE DESCRIPTION:**

Exercises in CAD/CAM theory and software at an intermediate level. The emphasis will be on the generation of CNC programs, at an intermediate level, for both CNC Mill, and CNC Lathe. This class is designed to allow the student the opportunity to improve efficiency in the application of immediate CAD/CAM. (FT) Transfer Credit: CSU

**PREREQUISITES:** **Concurrent enrollment, or completion with "C" or above, in Advanced CAD/CAM**

**COURSE OBJECTIVES:**

Each student successfully completing this course will:

1. Use verification software to analyze the effects of speeds, feeds and depth of cut and total volume of material removed with an intermediate level of quality and quantity of projects.
2. Demonstrate use of CAD/CAM software to create 2 and 3 dimensional geometric shapes and surface models on multiple level drawings and with required tool paths at an intermediate level of quality and quantity of projects.
3. Modify previously constructed 3 dimensional surface models.
4. Demonstrate the ability to modify post-processor and co-processor data files.
5. Perform editing of surface models.
6. Demonstrate proper use of utility packages in conjunction with CAM packages.
7. Demonstrate the basic use of multiple tool planes and multi-axis machining.
8. Demonstrate proper use of personal computers for routine maintenance of systems.
9. Complete assigned projects using required skills with limited hands-on instruction by the instructor.
10. Demonstrate a understanding of the DOS and Windows commands as used on personal computers at an intermediate level of quality and quantity of projects.
11. Demonstrate reading and writing skills to read and prepare required documents for course work.
12. Demonstrate communication skills to interact successfully with members of working teams and instructor.

**REQUIRED COURSE MATERIALS:**

**Textbooks:** Examples of appropriate textbooks include:
MasterCam For Windows, 1995
SmartCam Programming Manuals, 1992
Anilam Vertical Machining Program Manual, 1991

**Bendix Dynapath Manual**, 1989
**Fadal Programming Manual**, 1992
**Fanuc 6T Programming Manual**, 1988
**Greco System Manual**, 1992
**Vericut Programming Manual**, 1992
**N-See Programming Manual**, 1992
**Surfcam Programming Manual**, Current Edition

**Hand Tools/Supplies:** Computer diskettes

**METHOD OF INSTRUCTION:**

**Lecture:** Presentations will include:

1. Lecture with, or without, various audio-visual aids
2. Discussion, debate, and/or critique
3. Demonstration
4. Computer-assisted or other self-paced instruction
5. Field trips or field assignments
6. Laboratory assignments utilizing specifically planned instructional activities or "live" work.

**Laboratory:** Laboratory will be a "hands-on" process.

**Writing Assignments:** Writing assignments include:

1. Completing assigned reports
2. Providing written answers to assigned questions
3. Performing arithmetic calculations as assigned
4. Maintaining a notebook of class assignments and activities
5. Completing a 500 word written report dealing with a subject related to this course

**Appropriate Outside Assignments:** Students are expected to spend a minimum of two hours outside of class in practice and preparation for each hour in class. Appropriate assignments include:

1. Researching appropriate readings
2. Preparing research reports
3. Preparing writing assignments
4. Studying as needed to perform successfully in class

**Appropriate Assignments That Demonstrate Critical Thinking:** Students will be required to demonstrate verification and communication of their own programs.

1. Students must estimate machining time involved in producing a programmed work piece.
2. Students will interpret blueprints to produce required machine parts to specifications in the time allowed.
3. Students will be required to demonstrate using the basic DOS and Windows commands of a personal computer.
4. Students will be required to verify and communicate supplied programs, and make corrections and recommendations for efficiency and safety.

**Method of Evaluation:** A student's grade will be based on multiple measures of performance. The assessment will measure development of independent critical thinking skills and will include evaluation of the student's ability to:

1. perform the manipulative skills of the craft as required to satisfactorily complete laboratory assignments
2. apply theory to laboratory assignments
3. satisfactorily perform on written, oral, or practical examinations
4. satisfactorily perform on outside assignments including writing assignments
5. contribute to class discussions
6. maintain attendance per current policy
7. follow all laboratory rules and safety regulations

**LAB OUTLINE:**

| Lab Topics | Contact Hrs. |
|---|---|
| **Geometry Generation Review** | |
| A. Contours | |
| B. Pockets | |
| C. Lettering | |
| D. Drilling | |
| **Tool Paths Generation Review** | |
| A. Contours | |
| B. Pockets | |
| C. Lettering | |
| D. Drilling | |
| **Advanced Geometries** | |
| A. Ruled surfaces projection | |
| B. Coons surface projection | |
| C. Lofted surfaces projection | |
| D. 3-D Swept surfaces | |
| **Intermediate Files** | |
| A. Back plotting completed intermediate files for surfaces | |
| B. Editing intermediate files for surfaces | |
| C. Merging intermediate files for surfaces | |
| D. Projection of intermediate files onto surfaces | |
| **Generating CNC code review** | |
| A. Selection of post, or co-processors | |
| B. Operation of post, or co-processors | |
| C. Reverse postprocessing | |
| D. Edit processors | |
| **Communication parameters** | |
| A. Using CAM software to facilitate RS-232 interface | |
| B. Using CAM software to facilitate downloading of programs | |
| C. Using CAM software to facilitate uploading of programs | |
| D. Using CAM software to facilitate handshaking of machine centers with computers | |
| **Total Lecture Hours** | — |

## COURSE OBJECTIVES: TECHNICAL COMPETENCIES

After the successful completion of this course the student will be able to:

**A. CREATE DESIGNS WITH CAD SECTION OF CAD/CAM PROGRAM**

1. Create Advanced Geometric Surfaces at an Intermediate Level
   a. Create advanced geometric surfaces with intermediate quality and quantity of projects, including:
      (1) Lofted / Cross Section
      (2) Blend
      (3) Swept / Drive Curve
      (4) Trim
      (5) Coons / 4-Curve
      (6) Draft
      (7) Offset
      (8) Nurb Surface
      (9) Fillet
      (10) Parametric Surface
2. Edit Basic Geometric Entities
   a. Modify and edit advanced geometric surfaces with intermediate quality and quantity of projects, including:
      (1) Trimming
      (2) Breaking
      (3) Joining
      (4) Fillet
3. Edit Advanced Geometric Surfaces
   a. Modify and edit advanced geometric surfaces with intermediate quality and quantity of projects including:
      (1) Control points of nurbs
      (2) Conversion to nurbs entity
      (3) Extend entities
      (4) Drag entities
      (5) Edit entities
   b. Change cutter offset side
   c. Change cutting directions
   d. Turn surface normal arrows on and off
   e. Decompose composite surfaces
   f. Twist vectors of parametric surface
   g. Create polygons on surface
   h. Align surface normals
   i. Trim surfaces
   j. Untrim trimmed surfaces
4. Transform Geometric Entities using CAD Commands
   a. Scale X,Y, and Z at possible separate ratios
5. Execute Screen and Display Functions
   a. Use screen and display functions to:
      (1) Change surface density
      (2) Shade surface models
      (3) Blank and unblank entities

**B. PROCESS TOOL PATH DATA**

1. Generate Advanced Vertical Machining Code
   a. Generate Code for 3 axis surface machining to include:
      (1) Single surface machining, including roughing and finishing
      (2) Multiple surface machining, including roughing and finishing
   b. Generate code for 4 and 5 axis surface machining to include:
      (1) Single surface machining, including roughing and finishing
      (2) Multiple surface machining, including roughing and finishing
2. Import and Machine Scanned Data
   a. Import and machine 2 dimensional data
   b. Import and machine 3 dimensional data
3. Describe and Execute Post-Processor or Co-processor Functions
   a. Edit processors
4. Program Lathe or Turning Operations
   a. Use CAD section to create geometric designs with intermediate quality and quantity of projects
   b. Create lathe tools as required
5. Create Tool Path Information to Rough and Finish
   a. Create tool path information to rough and finish with intermediate quality and quantity of projects during:
      (1) Turning operations
      (2) Facing operations
      (3) Grooving operations
      (4) Internal boring operations/external boring operations
      (5) Internal and external threading

## COURSE OBJECTIVES: SCANS COMPETENCIES

*The Secretary's Commission on Achieving Necessary Skills (SCANS), U.S. Department of Labor, has identified in its "AMERICA 2000 REPORT" that all students should develop a new set of competencies and foundation skills if they are to enjoy a productive, full and satisfying life. These are in addition to the Technical Workplace Competencies required by industry. SCANS is made up of five competencies and a three-part foundation of skills and personal qualities that are needed for solid job performance.*

---

The following activities will be performed by each student for successful completion of this course:

**I. COMPETENCIES**

***A. Resources:*** *Identifies, organizes, plans, and allocates resources*

1. follows a schedule to complete assigned tasks on time
2. determine the initial cost of materials and "value added" as result of machining
3. provide a self-evaluation of performance based on the time and quality of work

***B. Interpersonal:*** *Works with others*

1. complete assigned responsibilities within the shop floor serving as a member of the team
2. provide individual assistance/direction to peers as requested
3. produce machine parts to acceptable levels of quality as required
4. works well with all members of the class

*C.* ***Information:*** *Acquires and uses information*

1. read and interpret blueprints
2. organize and apply theories of machine tool operation

*D.* ***Systems:*** *Understands complex inter-relationships*

1. demonstrate knowledge of the following systems:
   a. laboratory organization structure: physical and social
   b. organization of personnel and facilities on the shop floor
   c. systematic approach to the metal removal process
   d. dimensioning and measurement systems
   e. systematic organization of training materials
2. monitors and corrects performance during
   a. the machining process
   b. adjustments of individual laboratory work schedule
   c. constantly evaluating the quality of work to achieve acceptable standards
   d. maintains record of evaluations and sets individual goals

*E.* ***Technology:*** *Works with a variety of technologies*

1. chooses procedure, tools and equipment required to produce a part
2. applies appropriate procedures and uses appropriate tools and equipment to produce a machined part to acceptable standards
3. maintains and troubleshoots equipment
   a. applies appropriate preventative maintenance
   b. when operating machines
   c. reports all malfunctions of equipment to supervisor/instructor
   d. perform clean-up assignments of machine and shop floor at the end of the laboratory

## II. FOUNDATION SKILLS

*A.* ***Basic Skills:*** *Reads, writes, performs arithmetic and mathematical operations, listens and speaks.*

*1.* ***Reading:*** *Locates, understands, and interprets written information in prose and in documents such as manuals, graphs, and schedules*
   a. studies student laboratory manual
   b. interprets blueprints and technical drawings
   c. read/studies textbook
   d. follow a daily laboratory schedule to maintain appropriate time-line and product completion

*2.* ***Writing:*** *Communicates thoughts, ideas, information, and messages in writing; and creates documents such as letters, directions, manuals, reports, graphs, and flow charts*
   a. outline the steps necessary to produce a simple machine part
   b. maintain a lecture notebook
   c. submit written responses to chapter question assignments

d. complete all written assignments

3. ***Arithmetic/Mathematics:*** *Perform basic computations and approaches practical problems by choosing appropriately from a variety of mathematical techniques*
   a. determines optimum machining speeds, feeds, and depth of cut
   b. calculates "value added to the part"
   c. aligns machine and/or work holding device
   d. taps and threads
   e. keeps a running computation of individual grade
   f. interconverts fractions to decimal expressions
   g. use protractors to lay-out angle machining
   h. use trigonometry to solve angle and taper calculations
4. ***Listening:*** *Receives, attends to, interprets, and responds to verbal messages and other cues*
   a. assimilate classroom instruction
   b. interpret and assimilate video instruction
   c. observe laboratory demonstrations
   d. seek and receive individualized instruction in the laboratory
5. ***Speaking:*** *Organizes ideas and communicates orally*
   a. participates in classroom discussions
   b. organize ideas and communicate specific questions to the instructor
   c. verbally affirms understanding of a concept, procedure, or required skill
   d. communicates with peers to ensure the smooth and safe operation of the laboratory

B. ***Thinking Skills:*** *Thinks creatively, makes decisions, solves problems, visualizes, knows how to learn and reasons.*

1. ***Decision Making:*** *Specifies goals and constraints, generates alternatives, considers risks, and evaluates and chooses best alternative*
   a. identifies personal goals
   b. identifies actions required to accomplish personal goals
2. ***Problem Solving:*** *Recognizes problems and devises and implements plan of action*
   a. makes daily accommodations to stay on schedule
   b. seeks additional instruction/clarification for assignment completion
   c. balances social and academic life/responsibilities
   d. accepts responsibility
3. ***Seeing Things In the Mind's Eye:*** *Organizes, and processes symbols, pictures, graphs, objects, and other information*
   a. interprets technical drawings
   b. interprets technical illustrations and symbols
   c. understands both written and verbal instructions
   d. assimilates process during instructor demonstrations
4. ***Knowing How to Learn:*** *Use efficient learning techniques to acquire and apply new knowledge and skills*
   a. demonstrate mastery of the basic skills and techniques
   b. use these sequential skills to support mastery of new skills

c. understand the sequential nature of acquired skills and the subsequent knowledge application of new skills and techniques

5. ***Reasoning:*** *Discovers a rule or principle underlying the relationship between two or more objects and applies it when solving a problem*
   a. understands that practice may not make it perfect but it certainly will improve the skill of the operator
   b. understands that the quality of the product is a function of the time of the operation and the attitude and skill of the machinist
   c. understands the relationship between different metals and the tool applied to the metal surface and adjusts machining parameters accordingly

C. ***Personal Qualities:*** Displays responsibility, self-esteem, sociability, self-management, and integrity and honesty.

1. ***Responsibility:*** *Exerts a high level of effort and perseveres towards goal attainment*
   a. develops an understanding that in order to be successful you must be a "good" student
   b. develops an understanding that a "good" student is the one who is prompt to every class and has prepared for the day's work
   c. develops an understanding good students know what they are going to do in class and does not waste time
   d. develops a fine work-ethic

2. ***Self-Esteem:*** *Believes in own self-worth and maintains a positive view of self*
   a. learns to take pride in his or her work through positive reinforcement
   b. sees himself or herself as an asset to the class through continued contributions to the group and a shared common goal
   c. understands that an individual with a positive attitude and the belief in their own abilities will systematically seek solutions and be a valuable employee

3. ***Sociability:*** *Demonstrates understanding, friendliness, adaptability, empathy, and politeness in group settings*
   a. assist classmates in improving technical skills
   b. assist students with special needs as a peer mentor
   c. share laboratory resources (machines, tools and instructor's individual attention)

4. ***Self-Management:*** *Assesses self accurately, sets personal goals, monitors progress, and exhibits self-control*
   a. perform in-process quality checks on machined parts
   b. maintain a record of academic achievement (individual grade book)
   c. make accommodations to laboratory schedules due to broken machines/tools
   d. accept the responsibility for self-management

5. ***Integrity/Honesty:*** *Chooses ethical courses of action*
   a. accept the responsibility for own actions
   b. exhibit personal honesty at all times

c. accept the challenge of doing your own work in the laboratory, during examination, and on outside assignments

d. understand the consequences of unethical behaviors

MACT181
05/081596

***M*achine Tool *A*dvanced *S*kills**
***T*echnology Program**

# MAST

# COURSE SYLLABUS

# INTRODUCTION TO CNC CONTROLLED TURNING

# MAST PROGRAM
## COURSE SYLLABUS
## INTRODUCTION TO CNC CONTROLLED TURNING

**Lecture hours/week: 3** **Lab hours/week: 3** **Credit hours: 4**

**COURSE DESCRIPTION:**

Theory of CNC Turning techniques. Emphasis placed on basic operations of CNC Turning. Students in this class are expected to have previous machining experience. (FT) Transfer Credit: CSU.

**PREREQUISITES:** **Completion of Introduction to CNC and EDM with "C" or above**

**COURSE OBJECTIVES:**

Students successfully completing this course will be able to:

1. Use verification software to analyze the effects of speeds, feeds, and depth of cut and total volume of material removed.
2. Identify CNC Lathes and their controls and accessories.
3. Use charts, reference tables, math calculations to determine speeds and feeds.
4. Demonstrate the proper set up procedures for the Webb-Ecostar, ANSAM Lathemate and Bendix CNC lathes.
5. Demonstrate proper use of Controller to set offsets, edit programs, and create programs at the Controller.
6. Demonstrate a basic understanding of the common "G" & "M" codes as used on CNC machines to create various programs.
7. Complete assigned projects using required skills with hands-on instruction by the instructor.
8. Demonstrate reading and writing skills to read and prepare required documents for course work.
9. Demonstrate communication skills to interact successfully with members of working teams and instructor.

**REQUIRED COURSE MATERIALS:**

**Textbooks:** Examples of appropriate textbooks include:
Technology of Machine Tools, 4th Edition, 1989
Fundamentals of Numerical Control, 1990
Computer Numerical Control: From Programming to Networking, 1994
Fanuc 6T Programming Manual, 1988

Dynapath Lathe Manual, 1980
Greco Systems Manual, 1992
Anilam Lathemate Program Manuals, 1994

**Hand Tools/Supplies:** Computer Diskettes

## METHOD OF INSTRUCTION

**Lecture:** Presentations will include:

1. Lecture with, or without, various audio-visual aids
2. Discussion, debate, and/or critique
3. Demonstration
4. Computer-assisted or other self-paced instruction
5. Field trips or field assignments
6. Laboratory assignments utilizing specifically planned instructional activities or "live" work

**Laboratory:** Laboratory will be a "hands-on" process.

**Writing Assignments:** Writing assignments include:

1. Completing assigned reports
2. Providing written answers to assigned questions
3. Performing arithmetic calculations as assigned
4. Maintaining a notebook of class assignments and activities
5. Completing a 500 word report dealing with a subject related to this course

**Outside Assignments:** Students are expected to spend a minimum of two hours outside of class in practice and preparation for each hour in class. Appropriate assignments include:

1. Researching appropriate readings
2. Preparing research reports
3. Preparing writing assignments
4. Studying as needed to perform successfully in class

**Appropriate Assignments That Demonstrate Critical Thinking:**

1. Students will be required to demonstrate machining a work piece using their own program.
2. Students must estimate machining time involved in producing a programmed work piece.
3. Students will interpret blueprints to produce required machine parts to specifications in the time allowed.

**Method of Evaluation:** A student's grade will be based on multiple measures of performance. The assessment will measure development of independent critical thinking skills and will include evaluation of the student's ability to:

1. perform the manipulative skills of the craft as required to satisfactorily complete laboratory assignments

2. apply theory to laboratory assignments
3. satisfactorily perform on written, oral, or practical examinations
4. satisfactorily perform on outside assignments including writing assignments
5. contribute to class discussions
6. maintain attendance per current policy
7. follow all laboratory rules and safety regulations

**LECTURE OUTLINE:**

| Lecture Topics | Text Reference Page | Contact Hrs. |
|---|---|---|
| | | |
| | **Total Lecture Hours** | — |

**LAB OUTLINE:**

| Lab Topics | Contact Hrs. |
|---|---|
| | |
| **Total Lab Hours** | — |

**COURSE OBJECTIVES: TECHNICAL COMPETENCIES**

After the successful completion of this course the student will be able to:

**A. EXPLAIN CNC TURNING PROCESS, EQUIPMENT AND SAFETY**

1. Describe CNC Turning Process
   a. Describe history of CNC turning
   b. Describe use of various turning machines
2. Describe Theory of Operation
   a. Describe open and closed loop systems
   b. Describe various oil and air requirements
   c. Describe how turning centers function
3. Describe Nomenclature Used in CNC Turning
   a. Describe and identify common tools used to:
      (1) Turn
      (2) Drill
      (3) Groove
      (4) Face
      (5) Bore
      (6) Single point thread
      (7) Tap
   b. Describe and identify work holding devices used in turning, including:
      (1) 3-Jaw chuck
      (2) Collets

(3) Soft Jaw chucks
(4) Centers

c. Select proper cutting inserts relative to:
(1) Roughing
(2) Finishing
(3) Threading
(4) Different types of materials

4. Demonstrate Safety Practices Related to CNC Turning Centers

a. Demonstrate operating safety practices, including:
(1) Safety door interlocks
(2) Power box interlocks
(3) Tool loading and unloading
(4) Loading and unloading work holding devices
(5) Machine coolant disposal

b. Describe/identify personal safety equipment

**B. DESCRIBE CNC TURNING CENTER**

1. Describe Controller Functions, including:
a. Power meter
b. Option switches
c. Key lock
d. Emergency stop button
e. Rapid travel override
f. Feed rate override
g. Spindle speed override
h. Axis selector
i. Increment of movement selector
j. Slide hold
k. Start function

2. Describe Keyboard Functions, including:
a. Automatic mode
b. Manual MDI mode
c. Single step mode (Block-to-Block)
d. Jog mode
e. Spindle On/Off
f. Coolant On/Off
g. Turret clockwise (CW) and turret counterclockwise (CCW)

**C. SET-UP AND PROGRAM OPERATION OF CNC TURNING CENTER**

1. Determine and Set Machine Tool Operations, including:
a. Number of tools required
b. Maximum spindle speed and horsepower
c. Fast feed rate
d. Rapid positioning rate
e. Limits in X and Z axes
f. Memory size in controller
g. Oil and air requirements

h. Communication systems

2. Perform Basic Machine Set-Up
   a. Check Oil and Air Supply
   b. Turn power on
   c. Set machine home position
   d. Load tools into proper tool holders
   e. Load tools into tool carousel
   f. Set tool changer numbers
   g. Mount work piece into chuck
   h. Indicate work piece within specified tolerances
3. Set Tool Length Offsets
   a. Set tool length offsets using work piece
   b. Set tool length offsets using keyboard commands
   c. Modify length and diameter offsets using tool page editor
   d. Modify length and diameter offsets using keyboard
   e. Upload and download tool information to storage
4. Load Program
   a. Upload and download programs using RS-232 interface
   b. Upload and download programs using local area network (Greco System)
5. Edit Program for Machine Tool
   a. Edit program at machine tool using editor in controller
   b. Edit program using DOS and Windows editors
6. Create Program at Machine Tool for Common Machine Operations
   a. Use machine controller
   b. Use DOS editor
   c. Use Windows editor

**D. DEMONSTRATE MACHINING OF OBJECTS ON CNC TURNING CENTER**

1. Machine Objects, including:
   a. Outside Contours
   b. Grooves
   c. Drill and tapped holes
   d. Single point boring
   e. Reaming
   f. Single point thread internal and external
   g. Facing operations
   h. Turning tapers
2. Maintain Turning Center
   a. Mix coolant
   b. Determine need for coolant change
   c. Change coolant
   d. Clean coolant tank
   e. Clean machine
   f. Change oil filters
   g. Add lubricating fluid
   h. Add hydraulic fluid

i. Dispose of coolant and oils per EPA regulations

## COURSE OBJECTIVES: SCANS COMPETENCIES

*The Secretary's Commission on Achieving Necessary Skills (SCANS), U.S. Department of Labor, has identified in its "AMERICA 2000 REPORT" that all students should develop a new set of competencies and foundation skills if they are to enjoy a productive, full and satisfying life. These are in addition to the Technical Workplace Competencies required by industry. SCANS is made up of five competencies and a three-part foundation of skills and personal qualities that are needed for solid job performance.*

---

The following activities will be performed by each student for successful completion of this course:

**I. COMPETENCIES**

*A. **Resources:** Identifies, organizes, plans, and allocates resources*

1. follows a schedule to complete assigned tasks on time
2. determine the initial cost of materials and "value added" as result of machining
3. complete a stock request form for required material
4. provide a self-evaluation of performance based on the time and quality of work

*B. **Interpersonal:** Works with others*

1. complete assigned responsibilities within the shop floor serving as a member of the team
2. provide individual assistance/direction to peers as requested
3. produce machine parts to acceptable levels of quality as required
4. works well with all members of the class

*C. **Information:** Acquires and uses information*

1. read and interpret blueprints
2. organize and practically apply theories of machine tool operation
3. perform basic semi-precision and precision layout as necessary

*D. **Systems:** Understands complex inter-relationships*

1. demonstrate knowledge of the following systems:
   a. laboratory organization structure: physical and social
   b. organization of personnel and facilities on the shop floor
   c. systematic approach to the metal removal process
   d. dimensioning and measurement systems
   e. systematic organization of training materials
2. monitors and corrects performance during
   a. the machining process
   b. adjustments of individual laboratory work schedule

c. constantly evaluating the quality of work to achieve acceptable standards
d. maintains record of evaluations and sets individual goals

*E. **Technology:** Works with a variety of technologies*

1. chooses procedure, tools and equipment required to produce a part
2. applies appropriate procedures and uses appropriate tools and equipment to produce a machined part to acceptable standards
3. maintains and troubleshoots equipment
   a. applies appropriate preventative maintenance
   b. when operating machines
   c. reports all malfunctions of equipment to supervisor/instructor
   d. perform clean-up assignments of machine and shop floor at the end of the laboratory

## II. FOUNDATION SKILLS

*A. **Basic Skills:** Reads, writes, performs arithmetic and mathematical operations, listens and speaks.*

*1. **Reading:** Locates, understands, and interprets written information in prose and in documents such as manuals, graphs, and schedules*
   a. studies student laboratory manual
   b. interprets blueprints and technical drawings
   c. read/studies textbook
   d. follow a daily laboratory schedule to maintain appropriate time-line and product completion

*2. **Writing:** Communicates thoughts, ideas, information, and messages in writing; and creates documents such as letters, directions, manuals, reports, graphs, and flow charts*
   a. outline the steps necessary to produce a simple machine part
   b. maintain a lecture notebook
   c. submit written responses to chapter question assignments
   d. complete all written assignments

*3. **Arithmetic/Mathematics:** Perform basic computations and approaches practical problems by choosing appropriately from a variety of mathematical techniques*
   a. determines optimum machining speeds, feeds, and depth of cut
   b. calculates "value added to the part"
   c. aligns machine and/or work holding device
   d. taps and threads
   e. keeps a running computation of individual grade
   f. interconverts fractions to decimal expressions
   g. use protractors to lay-out angle machining
   h. use trigonometry to solve angle and taper calculations

*4. **Listening:** Receives, attends to, interprets, and responds to verbal messages and other cues*
   a. assimilate classroom instruction

b. interpret and assimilate video instruction
c. observe laboratory demonstrations
d. seek and receive individualized instruction in the laboratory

5. ***Speaking:*** *Organizes ideas and communicates orally*
   a. participates in classroom discussions
   b. organize ideas and communicate specific questions to the instructor
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   d. communicates with peers to ensure the smooth and safe operation of the laboratory

B. ***Thinking Skills:*** *Thinks creatively, makes decisions, solves problems, visualizes, knows how to learn and reasons.*

1. ***Decision Making:*** *Specifies goals and constraints, generates alternatives, considers risks, and evaluates and chooses best alternative*
   a. identifies personal goals
   b. identifies actions required to accomplish personal goals

2. ***Problem Solving:*** *Recognizes problems and devises and implements plan of action*
   a. makes daily accommodations to stay on schedule
   b. seeks additional instruction/clarification for assignment completion
   c. balances social and academic life/responsibilities
   d. accepts responsibility

3. ***Seeing Things In the Mind's Eye:*** *Organizes, and processes symbols, pictures, graphs, objects, and other information*
   a. interprets technical drawings
   b. interprets technical illustrations and symbols
   c. understands both written and verbal instructions
   d. assimilates process during instructor demonstrations

4. ***Knowing How to Learn:*** *Use efficient learning techniques to acquire and apply new knowledge and skills*
   a. demonstrate mastery of the basic skills and techniques
   b. use these sequential skills to support mastery of new skills
   c. understand the sequential nature of acquired skills and the subsequent knowledge application of new skills and techniques

5. ***Reasoning:*** *Discovers a rule or principle underlying the relationship between two or more objects and applies it when solving a problem*
   a. understands that practice may not make it perfect but it certainly will improve the skill of the operator
   b. understands that the quality of the product is a function of the time of the operation and the attitude and skill of the machinist
   c. understands the relationship between different metals and the tool applied to the metal surface and adjusts machining parameters accordingly

C. ***Personal Qualities:*** *Displays responsibility, self-esteem, sociability, self-management, and integrity and honesty.*

1. ***Responsibility:*** *Exerts a high level of effort and perseveres towards goal attainment*
   a. develops an understanding that in order to be successful you must be a "good" student
   b. develops an understanding that a "good" student is the one who is prompt to every class and has prepared for the day's work
   c. develops an understanding good students know what they are going to do in class and does not waste time
   d. develops a fine work-ethic
2. ***Self-Esteem:*** *Believes in own self-worth and maintains a positive view of self*
   a. learns to take pride in his or her work through positive reinforcement
   b. sees himself or herself as an asset to the class through continued contributions to the group and a shared common goal
   c. understands that an individual with a positive attitude and the belief in their own abilities will systematically seek solutions and be a valuable employee
3. ***Sociability:*** *Demonstrates understanding, friendliness, adaptability, empathy, and politeness in group settings*
   a. assist classmates in improving technical skills
   b. assist students with special needs as a peer mentor
   c. share laboratory resources (machines, tools and instructor's individual attention)
4. ***Self-Management:*** *Assesses self accurately, sets personal goals, monitors progress, and exhibits self-control*
   a. perform in-process quality checks on machined parts
   b. maintain a record of academic achievement (individual grade book)
   c. make accommodations to laboratory schedules due to broken machines/tools
   d. accept the responsibility for self-management
5. ***Integrity/Honesty:*** *Chooses ethical courses of action*
   a. accept the responsibility for own actions
   b. exhibit personal honesty at all times
   c. accept the challenge of doing your own work in the laboratory, during examination, and on outside assignments
   d. understand the consequences of unethical behaviors

***M*achine Tool *A*dvanced *S*kills**
***T*echnology Program**

# MAST

# COURSE SYLLABUS

# APPLICATIONS OF CNC CONTROLLED TURNING

# MAST PROGRAM
## COURSE SYLLABUS
## APPLICATIONS OF CNC CONTROLLED TURNING I

**Lecture hours/week: 0** **Lab hours/week: 6** **Credit hours: 2**

**COURSE DESCRIPTION:**

Exercises in CNC Turning techniques at an intermediate level. Emphasis placed on basic operations of CNC Turning. This class is designed to allow the student the opportunity to gain speed and efficiency in the hands on application of Turning operations at an intermediate level. Students in this class are expected to have previous machining experience. (FT)
Transfer Credit: CSU.

**PREREQUISITES:** **Concurrent enrollment, or completion with "C" or above, in Introduction to CNC Controlled Turning**

**COURSE OBJECTIVES:**

Students successfully completing this course will be able to:

1. Identify CNC Lathes and their controls and accessories to complete specific operations.
2. Use verification software to analyze the effects of speeds, feeds, and depth of cut and total volume of material removal with an intermediate level of quality and quantity of projects.
3. Demonstrate the proper set up procedures for the Webb-Ecostar, ANILAM Lathemate, and Bendix CNC lathes using soft-jaws.
4. Demonstrate proper use of Controller to modify subroutines and macros.
5. Demonstrate an intermediate understanding of the common "G" & "M" codes as used on CNC Machines to create various programs.
6. Complete assigned projects using required skills with limited hands-on instruction by the instructor.
7. Demonstration reading and writing skills to read and prepare required documents for course work.
8. Demonstrate communication skills to interact successfully with members of working teams and instructor.

**REQUIRED COURSE MATERIALS:**

**Textbooks:** Examples of appropriate textbooks include:
Technology of Machine Tools, 4th Edition, 1989
Fundamentals of Numerical Control, 1990
Computer Numerical Control: From Programming to Networking, 1994
Fanuc 6T Programming Manual, 1988
Dynapath Lathe Manual, 1980
Greco Systems Manual, 1992

**ANILAM Lathemate Program Manuals**, 1994
**Anilam Vertical Machining Program Manual**, 1991

**Hand Tools/Supplies:** Computer Diskettes

## METHOD OF INSTRUCTION

**Lecture:** Presentations will include:

1. Lecture with, or without, various audio-visual aids
2. Discussion, debate, and/or critique
3. Demonstration
4. Computer-assisted or other self-paced instruction
5. Field trips or field assignments
6. Laboratory assignments utilizing specifically planned instructional activities or "live" work

**Laboratory:** Laboratory will be a "hands-on" process

**Writing Assignments:** Writing assignments include:

1. Completing assigned reports
2. Providing written answers to assigned questions
3. Performing arithmetic calculations as assigned
4. Maintaining a notebook of class assignments and activities
5. Completing a 500 word report dealing with a subject related to this course

**Outside Assignments:** Students are expected to spend a minimum of two hours outside of class in practice and preparation for each hour in class. Appropriate assignments include:

1. Researching appropriate readings
2. Preparing research reports
3. Preparing writing assignments
4. Studying as needed to perform successfully in class

**Appropriate Assignments That Demonstrate Critical Thinking:**

1. Students will be required to demonstrate machining a work piece using their own program.
2. Students must estimate machining time involved in producing a programmed work piece.
3. Students will interpret blueprints to produce required machine parts to specifications in the time allowed.

**Method of Evaluation:** A student's grade will be based on multiple measures of performance. The assessment will measure development of independent critical thinking skills and will include evaluation of the student's ability to:

1. perform the manipulative skills of the craft as required to satisfactorily complete laboratory assignments
2. apply theory to laboratory assignments
3. satisfactorily perform on written, oral, or practical examinations
4. satisfactorily perform on outside assignments including writing assignments

5. contribute to class discussions
6. maintain attendance per current policy
7. follow all laboratory rules and safety regulations

**LAB OUTLINE:**

| Lab Topics | Contact Hrs. |
|---|---|
| | |
| **Total Lab Hours** | — |

**COURSE OBJECTIVES: TECHNICAL COMPETENCIES**

After the successful completion of this course the student will be able to:

**A. SET-UP AND PROGRAM OPERATION OF CNC TURNING CENTER**

1. Determine and Set Machine Tool Operations, including:
   a. Number of tools required
   b. Maximum spindle speed and horsepower
   c. Fast feed rate
   d. Rapid positioning rate
   e. Limits in X and Z axes
   f. Memory size in controller
   g. Oil and air requirements
   h. Communication systems
2. Perform Basic Machine Set-Up
   a. Check Oil and Air Supply
   b. Turn power on
   c. Set machine home position
   d. Load tools into proper tool holders
   e. Load tools into tool carousel
   f. Set tool changer numbers
   g. Mount work piece into chuck
   h. Indicate work piece within specified tolerances
3. Set Tool Length Offsets
   a. Set tool length offsets using work piece
   b. Set tool length offsets using keyboard commands
   c. Modify length and diameter offsets using tool page editor
   d. Modify length and diameter offsets using keyboard
   e. Upload and download tool information to storage
4. Load Program
   a. Upload and download programs using RS-232 interface
   b. Upload and download programs using local area network (Greco System)
5. Edit Program for Machine Tool
   a. Edit program at machine tool using editor in controller
   b. Edit program using DOS and Windows editors
6. Create Program at Machine Tool for Common Machine Operations

a. Use machine controller
b. Use DOS editor
c. Use Windows editor

**B. DEMONSTRATE MACHINING OF OBJECTS ON CNC TURNING CENTER**

1. Demonstrate Safety Practices Related to CNC Turning Centers
   a. Demonstrate operating safety practices including:
      (1) Safety door interlocks
      (2) Power door interlocks
      (3) Tool loading and unloading
      (4) Loading and unloading work holding devices
      (5) Machine coolant disposal
   b. Describe/Identify personal safety equipment
2. Machine Objects with Intermediate Level Quality and Quantity of Projects, including:
   a. Outside Contours
   b. Grooves
   c. Drill and tapped holes
   d. Single point boring
   e. Reaming
   f. Single point thread internal and external
   g. Facing operations
   h. Turning tapers
3. Maintain Turning Center
   a. Mix coolant
   b. Determine need for coolant change
   c. Change coolant
   d. Clean coolant tank
   e. Clean machine
   f. Change oil filters
   g. Add lubricating fluid
   h. Add hydraulic fluid
   i. Dispose of coolant and oils per EPA regulations

## COURSE OBJECTIVES: SCANS COMPETENCIES

*The Secretary's Commission on Achieving Necessary Skills (SCANS), U.S. Department of Labor, has identified in its "AMERICA 2000 REPORT" that all students should develop a new set of competencies and foundation skills if they are to enjoy a productive, full and satisfying life. These are in addition to the Technical Workplace Competencies required by industry. SCANS is made up of five competencies and a three-part foundation of skills and personal qualities that are needed for solid job performance.*

---

The following activities will be performed by each student for successful completion of this course:

I. **COMPETENCIES**

*A.* ***Resources:*** *Identifies, organizes, plans, and allocates resources*

1. follows a schedule to complete assigned tasks on time
2. determine the initial cost of materials and "value added" as result of machining.
3. provide a self-evaluation of performance based on the time and quality of work

*B.* ***Interpersonal:*** *Works with others*

1. complete assigned responsibilities within the shop floor serving as a member of the team
2. provide individual assistance/direction to peers as requested
3. produce machine parts to acceptable levels of quality as required
4. works well with all members of the class

*C.* ***Information:*** *Acquires and uses information*

1. read and interpret blueprints
2. organize and apply theories of machine tool operation

*D.* ***Systems:*** *Understands complex inter-relationships*

1. demonstrate knowledge of the following systems:
   a. laboratory organization structure: physical and social
   b. organization of personnel and facilities on the shop floor
   c. systematic approach to the metal removal process
   d. dimensioning and measurement systems
   e. systematic organization of training materials
2. Monitors and corrects performance during
   a. the machining process
   b. adjustments of individual laboratory work schedule
   c. constantly evaluating the quality of work to achieve acceptable standards
   d. maintains record of evaluations and sets individual goals

*E.* ***Technology:*** *Works with a variety of technologies*

1. chooses procedure, tools and equipment required to produce a part
2. applies appropriate procedures and uses appropriate tools and equipment to produce a machined part to acceptable standards
3. maintains and troubleshoots equipment
   a. applies appropriate preventative maintenance
   b. when operating machines
   c. reports all malfunctions of equipment to supervisor/instructor
   d. perform clean-up assignments of machine and shop floor at the end of the laboratory

II. **FOUNDATION SKILLS**

*A.* ***Basic Skills:*** *Reads, writes, performs arithmetic and mathematical operations, listens and speaks.*

*1.* ***Reading:*** *Locates, understands, and interprets written information in prose and in documents such as manuals, graphs, and schedules*

a. studies student laboratory manual

b. interprets blueprints and technical drawings
c. read/studies textbook
d. follow a daily laboratory schedule to maintain appropriate time-line and product completion

2. ***Writing:*** *Communicates thoughts, ideas, information, and messages in writing; and creates documents such as letters, directions, manuals, reports, graphs, and flow charts*
   a. outline the steps necessary to produce a simple machine part
   b. maintain a lecture notebook
   c. submit written responses to chapter question assignments
   d. complete all written assignments
3. ***Arithmetic/Mathematics:*** *Perform basic computations and approaches practical problems by choosing appropriately from a variety of mathematical techniques*
   a. determines optimum machining speeds, feeds, and depth of cut
   b. calculates "value added to the part"
   c. aligns machine and/or work holding device
   d. taps and threads
   e. keeps a running computation of individual grade
   f. interconverts fractions to decimal expressions
   g. use protractors to lay-out angle machining
   h. use trigonometry to solve angle and taper calculations
4. ***Listening:*** *Receives, attends to, interprets, and responds to verbal messages and other cues*
   a. assimilate classroom instruction
   b. interpret and assimilate video instruction
   c. observe laboratory demonstrations
   d. seek and receive individualized instruction in the laboratory
5. ***Speaking:*** *Organizes ideas and communicates orally*
   a. participates in classroom discussions
   b. organize ideas and communicate specific questions to the instructor
   c. verbally affirms understanding of a concept, procedure, or required skill
   d. communicates with peers to ensure the smooth and safe operation of the laboratory

B. ***Thinking Skills:*** *Thinks creatively, makes decisions, solves problems, visualizes, knows how to learn and reasons.*

1. ***Decision Making:*** *Specifies goals and constraints, generates alternatives, considers risks, and evaluates and chooses best alternative*
   a. identifies personal goals
   b. identifies actions required to accomplish personal goals
2. ***Problem Solving:*** *Recognizes problems and devises and implements plan of action*
   a. makes daily accommodations to stay on schedule
   b. seeks additional instruction/clarification for assignment completion
   c. balances social and academic life/responsibilities

d. accepts responsibility

3. ***Seeing Things In the Mind's Eye:*** *Organizes, and processes symbols, pictures, graphs, objects, and other information*
   a. interprets technical drawings
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   a. assist classmates in improving technical skills
   b. assist students with special needs as a peer mentor

c. share laboratory resources (machines, tools and instructor's individual attention)

4. ***Self-Management:*** *Assesses self accurately, sets personal goals, monitors progress, and exhibits self-control*
   a. perform in-process quality checks on machined parts
   b. maintain a record of academic achievement (individual grade book)
   c. make accommodations to laboratory schedules due to broken machines/tools
   d. accept the responsibility for self-management

5. ***Integrity/Honesty:*** *Chooses ethical courses of action*
   a. accept the responsibility for own actions
   b. exhibit personal honesty at all times
   c. accept the challenge of doing your own work in the laboratory, during examination, and on outside assignments
   d. understand the consequences of unethical behaviors

# APPENDIX A - INDUSTRY COMPETENCY PROFILES

The following pages contain the individual Competency Profiles for each of the companies surveyed by the MAST development center for the occupational specialty area of . These Competency Profiles/skill standards were used to develop the curriculum for the pilot program.

The participation of the companies as partners in the MAST effort is greatly appreciated. Each company has approved the use of its logo in MAST materials. None of the participating companies shall be held responsible or liable for any of the findings of the project.

**SKILLS AND KNOWLEDGE**

Communication Skills
Use Measurement Tools
Use Inspection Devices
Mathematical Skills
Reading/Writing Skills
Knowledge of Safety Regulations
Practice Safety in the Workplace
Organizational Skills
Knowledge of Company Policies/Procedures
Mechanical Aptitude
Ability to Comprehend Written/Verbal Instructions
Basic Knowledge of Fasteners
Ability to Work as Part of a Team
Converse in the Technical Language of the Trade
Knowledge of Occupational Opportunities
Knowledge of Employee/Employer Responsibilities
Knowledge of Company Quality Assurance Activities
Practice Quality-Consciousness in Performance of the Job


**TEXAS STATE TECHNICAL COLLEGE WACO**
**MAST PROGRAM REPRESENTATIVES**

DR. HUGH K. ROGERS
Director

DR. JON BOTSFORD
Assistant Director

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Project Coordinator

TERRY SAWMA
Research Coordinator

WALLACE PELTON
Site Coordinator

ROSE MARY TIMMONS
Senior Secretary/Statistician

**Furnished By:**

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Assistant Director of Manufacturing

RICHARD M. WONG
Sr. Manufacturing Engineer

VICTOR QUIJADA
CNC Machinist

THANH HO
CNC Machinist


Texas State Technical College Waco

**TRAITS AND ATTITUDES**

Strong Work Ethic
Interpersonal Skills
Punctuality
Dependability
Honesty
Neatness
Safety Conscientious
Motivation
Responsible
Physical Ability
Professional
Trustworthy
Customer Relations
Personal Ethics

**TOOLS AND EQUIPMENT**

Machinist's Tools (e.g., calipers, dial indicators magnetic tool holders, etc.)
Measuring Tools
Power Tools
Metal Lathe with Attachments
Drill Presses
Vertical Mill with Attachments
Power Saws
Power Drills
Hydraulic/Arbor Press
Heat Treatment Equipment
Hardness Testing Equipment
Grinding Machines with Attachments
Welding Equipment (SMAW, GMAW, FCAW, Plasma)
CNC Machining Center and Turning Center
Gear Producing Machines with Attachments
Jig Boring Machines
Alignment/Calibration Tools
Coolant Recovery Equipment
Computer
Ventilation Equipment
Forklift
Personal Safety Equipment
Oxyacetylene Equipment
Tool Storage Equipment
Workbenches
Vises
Pedestal Grinders
Weld Test Equipment
Optical Comparator
Coordinate Measurement Machine
Hydraulic/Pneumatic Training Equipment
Electrical Training Equipment
Safety Training Equipment

**FUTURE TRENDS AND CONCERNS**

Statistical Process Control
Composites
Laser Machining
Advanced Computer Applications
Robotics
Environmental Concerns
Fiber Optic Controls
Automated Material Handling Equipment
Computer Integrated Manufacturing



# COMPETENCY PROFILE

# CNC Machinist

**Prepared By**
**M.A.S.T.**
**Machine Tool Advanced Skills**
**Technology Program**
**and**
**Consortia Partners**
**(V.199J40008)**

Texas State Technical College Waco

BOWEN®



BEST COPY AVAILABLE

**CNC MACHINIST**.... program, edit, setup, and operate CNC lathes, mills and grinders to perform machining operations necessary to produce workpieces to referenced engineering standards.

| Duties | Tasks | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| A Practice Safety | A-1 Follow safety manuals and all safety regulations/ requirements | A-2 Use protective equipment | A-3 Follow safe operating procedures for CNC machines | A-4 Maintain a clean and safe work environment | | | | | | | | | |
| B Apply Mathematical Concepts | B-1 Perform basic arithmetic functions | B-2 Locate machining points from a datum point | B-3 Inter-convert fractions/ decimals | B-4 Inter-convert Metric/ English measurements | B-5 Perform basic trigonometric functions | | | | | | | | |
| C Interpret Engineering Drawings and Control Documents | C-1 Review blueprint notes and dimensions | C-2 Identify basic layout of drawings | C-3 Identify basic types of drawings | C-4 List the purpose of each type of drawing | C-5 Verify drawing elements | C-6 Describe the relationship of engineering drawings to planning | C-7 Use standards to verify require-ments | C-8 Analyze bill of materials (BOM) | | | | | |
| D Perform Measurement/ Inspection | D-1 Identify types of measurement | D-2 Select proper measurement tools | D-3 Apply proper measuring techniques | D-4 Use Metric and English standards of measurement | D-5 Perform measurements with hand held instruments | D-6 Perform measurements on surface plate | | | | | | | |
| E Perform Conventional Machining Operations | E-1 Prepare and plan for machining operations | E-2 Use proper hand tools | E-3 Operate power saws | E-4 Operate drill presses | E-5 Operate vertical milling machines | E-6 Operate horizontal milling machines | E-7 Operate metal cutting lathes | | | | | | |
| F Perform CNC Machining Functions | F-1 Prepare and plan for CNC machining operations | F-2 Select and use CNC tooling systems | F-3 Program CNC machines | F-4 Operate CNC machin-ing centers (mills) | F-5 Operate CNC turning centers (lathes) | F-6 Operate CNC grinders | F-7 Download programs via network | | | | | | |
| G Recognize Different Manufacturing Materials and Processes | G-1 Identify materials with desired properties | G-2 Describe the heat treating process | G-3 Describe casting process | G-4 Describe forging process | G-5 Describe color coding systems for metals | | | | | | | | |
| H Use Computers | H-1 Use computer operating systems | H-2 Use computer inquiry systems | H-3 Use various computer applications | | | | | | | | | | |
| I Participate in Total Quality and SPC Activities | I-1 Define quality in manufacturing and explain importance | I-2 Perform Statistical Process Control (SPC) functions | I-3 Analyze machining problems and recommend solutions | | | | | | | | | | |



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**SKILLS AND KNOWLEDGE**

Communication Skills
Use Measurement Tools
Use Inspection Devices
Mathematical Skills
Reading/Writing Skills
Knowledge of Safety Regulations
Practice Safety in the Workplace
Organizational Skills
Knowledge of Company Policies/Procedures
Mechanical Aptitude
Ability to Comprehend Written/Verbal Instructions
Knowledge of Cutting Fluids/Lubricants
Basic Knowledge of Fasteners
Ability to Work as Part of a Team
Converse in the Technical Language of the Trade
Knowledge of Occupational Opportunities
Knowledge of Employee/Employer Responsibilities
Knowledge of Company Quality Assurance Activities
Practice Quality-Consciousness in Performance of the Job


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JERRY CRAWFORD
Division Manager

RICHARD GRIFFIN
Manufacturing Manager

KAYLE ROWLEE
Machine/Fabrication Shop Supervisor


Texas State Technical College Waco

**TRAITS AND ATTITUDES**

Strong Work Ethic
Interpersonal Skills
Punctuality
Dependability
Honesty
Neatness
Safety Conscientious
Motivation
Responsible
Physical Ability
Professional
Trustworthy
Customer Relations
Personal Ethics

**TOOLS AND EQUIPMENT**

Machinist's Tools (e.g., calipers, dial indicators, magnetic tool holders, etc.)
Measuring Tools
Power Tools
Metal Lathe with Attachments
Drill Presses
Vertical Mill with Attachments
Power Saws
Power Drills
Hydraulic/Arbor Press
Heat Treatment Equipment
Hardness Testing Equipment
Grinding Machines with Attachments
Welding Equipment (SMAW, GMAW, FCAW)
CNC Machining Center and Turning Center
Gear Producing Machines with Attachments
Alignment/Calibration Tools
Coolant Recovery Equipment
Computer
Ventilation Equipment
Forklift
Personal Safety Equipment
Oxyacetylene Equipment
Tool Storage Equipment
Workbenches
Vises
Pedestal Grinders
Weld Test Equipment
Optical Comparator
Coordinate Measurement Machine
Hydraulic/Pneumatic Training Equipment
Electrical Training Equipment
Safety Training Equipment

**FUTURE TRENDS AND CONCERNS**

Statistical Process Control
Composites
Laser Machining
Advanced Computer Applications
Robotics
Environmental Concerns
Fiber Optic Controls
Automated Material Handling Equipment
Computer Integrated Manufacturing



# COMPETENCY PROFILE
# CNC Machinist

**Conducted By**
**M.A.S.T.**
**Machine Tool Advanced Skills**
**Technology Program**
**and**
**Consortia Partners**
**(V.199J40008)**

Texas State Technical College Waco

**CHRYSLER TECHNOLOGIES**
**AIRBORNE SYSTEMS, INC.**

**CNC MACHINIST**.... **program, edit, setup, and operate CNC lathes, mills and grinders to perform machining operations necessary to produce workpieces to referenced engineering standards.**

| Duties | Tasks | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| A Practice Safety | A-1 Follow safety manuals, and all safety regulations/ requirements (Haz. Com. Act) | A-2 Use protective equipment | A-3 Follow safe operating procedures for hand and machine tools | A-4 Maintain a clean and safe work environment | | | | | | | | | |
| B Apply Mathematical Concepts | B-1 Perform basic arithmetic functions | B-2 Interconvert fractions/ decimals | B-3 Interconvert Metric/English measurements | B-4 Perform basic trigonometric functions | B-5 Calculate speeds and feeds for machining | B-6 Locate machining points from a datum point | B-7 Perform calculations for sine bar and sine plate | B-8 Calculate for direct, simple, and angular indexing | B-9 Perform calculations necessary for turning tapers | B-10 Solve for little "h" | | | |
| C Interpret Engineering Drawings and Control Documents | C-1 Review blueprint notes and dimensions | C-2 Identify basic layout of drawings | C-3 Identify basic types of drawings | C-4 List the purpose of each type of drawing | C-5 Verify drawing elements | C-6 Practice geometric dimensioning and tolerancing (GD&T) methodology | C-7 Describe the relationship of engineering drawings to planning | C-8 Use standards to verify requirements | C-9 Analyze bill of materials (BOM) | | | | |
| D Recognize Different Manufacturing Materials and Processes | D-1 Identify materials with desired properties | D-2 Describe the heat treating process | D-3 Perform heat treating operations | D-4 Test metal samples for hardness | D-5 Identify types of plastic materials and processes | | | | | | | | |
| E Perform Measurement/ Inspection | E-1 Identify types of measurements | E-2 Select proper measurement tools | E-3 Apply proper measuring techniques | E-4 Use Metric and English standards of measurement | E-5 Perform measurements with hand held instruments | E-6 Perform measurements on surface plate | E-7 Perform inspections using stationary equipment | | | | | | |
| F Perform Conventional Machining Operations | F-1 Prepare and plan for machining operations | F-2 Use proper hand tools | F-3 Operate power saws | F-4 Operate drill presses | F-5 Operate vertical milling machines | F-6 Operate horizontal milling machines | F-7 Operate metal cutting lathes | F-8 Operate tool and cutter grinders | F-9 Perform preventative maintenance | | | | |
| G Perform CNC Machining Functions | G-1 Prepare and plan for CNC machining operations | G-2 Select and use CNC tooling systems | G-3 Program CNC machines | G-4 Operate CNC machining centers (mills) | G-5 Operate CNC turning centers (lathes) | G-6 Operate CNC grinders | G-7 Download programs via network | G-8 Use probe technology | G-9 Perform preventative maintenance | | | | |
| H Use a CAM System for CNC Programming | H-1 Access a PC based CAM system | H-2 Input the tool information necessary to machine the part | H-3 Input geometric data for part construction | H-4 Generate CNC code | H-5 Use Pro-Review engineering software | | | | | | | | |
| I Use Computers | I-1 Use computer operating systems | I-2 Use computer inquiry systems | I-3 Use various computer applications | I-4 Use bar coding | I-5 Use CAD/ CAM system | | | | | | | | |
| J Participate in Total Quality and SPC Activities | J-1 Define quality in manufacturing and explain importance | J-2 Perform Statistical Process Control (SPC) functions | J-3 Analyze machining problems and recommend solutions | | | | | | | | | | |

**SKILLS AND KNOWLEDGE**

Communication Skills
Use Measurement Tools
Use Inspection Devices
Mathematical Skills
Reading/Writing Skills
Knowledge of Safety Regulations
Practice Safety in the Workplace
Organizational Skills
Knowledge of Company Policies/Procedures
Mechanical Aptitude
Ability to Comprehend Written/Verbal Instructions
Basic Knowledge of Fasteners
Ability to Work as Part of a Team
Converse in the Technical Language of the Trade
Knowledge of Occupational Opportunities
Knowledge of Employee/Employer Responsibilities
Knowledge of Company Quality Assurance Activities
Practice Quality-Consciousness in Performance of the Job


SAN DIEGO CITY COLLEGE
CENTER FOR APPLIED COMPETITIVE
TECHNOLOGIES (CACT)
MAST PROGRAM REPRESENTATIVES

DR. JOAN A. STEPSIS
Dean/Director-CACT

JOHN BOLLINGER
Subject Matter Expert

FACILITATED BY:

MARY BENARD
Site Coordinator

LOUIS A. SPAIN, JR.
Consultant


**TRAITS AND ATTITUDES**

Strong Work Ethic
Interpersonal Skills
Punctuality
Dependability
Honesty
Neatness
Safety Conscientious
Motivation
Responsible
Physical Ability
Professional
Trustworthy
Customer Relations
Personal Ethics

**TOOLS AND EQUIPMENT**

Machinist's Tools (e.g., calipers, dial indicators magnetic tool holders, etc.)
Measuring Tools
Power Tools
Metal Lathe with Attachments
Drill Presses
Vertical Mill with Attachments
Power Saws
Power Drills
Hydraulic/Arbor Press
Heat Treatment Equipment
Hardness Testing Equipment
Grinding Machines with Attachments
Welding Equipment (SMAW, GMAW, FCAW, Plasma)
CNC Machining Center and Turning Center
Gear Producing Machines with Attachments
Jig Boring Machines
Alignment/Calibration Tools
Coolant Recovery Equipment
Computer
Ventilation Equipment
Forklift
Personal Safety Equipment
Oxyacetylene Equipment
Tool Storage Equipment
Workbenches
Vises
Pedestal Grinders
Weld Test Equipment
Optical Comparator
Coordinate Measurement Machine
Hydraulic/Pneumatic Training Equipment
Electrical Training Equipment
Safety Training Equipment

**FUTURE TRENDS AND CONCERNS**

Statistical Process Control
Composites
Laser Machining
Advanced Computer Applications
Robotics
Environmental Concerns
Fiber Optic Controls
Automated Material Handling Equipment
Computer Integrated Manufacturing



# COMPETENCY PROFILE

# CNC Machinist


**Prepared By**
**M.A.S.T.**
**Machine Tool Advanced Skills**
**Technology Program**
**and**
**Consortia Partners**
**(V.199J40008)**


**Davis** *Technologies*

**CNC MACHINIST**.... **program, edit, setup, and operate CNC lathes, mills and grinders to perform machining operations necessary to produce workpieces to referenced engineering standards.**

| Duties | Tasks | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| A Practice Safety | A-1 Use proper safety equipment | A-2 Identify proper clothing | A-3 State proper attitudes for safety | A-4 Handle chemicals properly | A-5 Identify fire hazards in machining | A-6 Demonstrate proper personal hygiene | A-7 Demonstrate proper laboratory cleaning | | | | | | |
| B Perform Measurements | B-1 Identify applications and limitations of measuring instruments | B-2 Demonstrate use of measuring instruments | | | | | | | | | | | |
| C Apply Mathematical Concepts | C-1 Perform mathematical computations with calculator | C-2 Calculate fractions and decimals with calculator | C-3 Convert Metric and US standard units of measure | C-4 Perform RPM calculations | C-5 Perform feed calculations | C-6 Perform depth of cut calculations | C-7 Perform thread cutting calculations | C-8 Perform tap drill calculations | C-9 Interpret reference tables related to machining | C-10 Apply Cartesian coordinate system in machining | C-11 Perform trigonometric calculations | C-12 Perform Pythagorean Theorem calculations | C-13 Perform polar trigonometry calculations |
| D Read Blueprints | D-1 Describe types of blueprint drawings | D-2 Describe blueprint dimensions | D-3 Interpret title, notes, revision and material information | D-4 Interpret blueprint drawings | | | | | | | | | |
| E Program CNC Machines & EDM | E-1 Demonstrate cutting tool identification and application | E-2 Identify and describe machine operation nomenclature | | | | | | | | | | | |
| F Operate CNC Machines & EDM | F-1 Describe vertical machining process and safety | F-2 Describe vertical machining functions | F-3 Set-up and program operation of vertical machine | F-4 Deomonstrate machining of objects on vertical machining center | F-5 Perform advance EDM operations | F-6 Describe turning process, equipment, and safety | F-7 Describe turning center | F-8 Set-up and program operation of turning center | F-9 Demonstrate machining of objects on turning center | | | | |
| G Use Computers | G-1 Demonstrate use of computer hardware | G-2 Select/use computer operating systems | G-3 Demonstrate use of basic DOS commands | G-4 Demonstrate use of Windows and Windows NT commands | G-5 Demonstrate use of MACROS in Windows and Windows NT programs | G-6 Demonstrate use of computer communication systems | | | | | | | |
| H Use CNC Verification Programs | H-1 Identify CNC verification software programs | H-2 Program and create CNC verification using program icons | H-3 Program CNC verification using pull-down menus | | | | | | | | | | |
| I Use CAD/ CAM Programs | I-1 Demonstrate understanding of CAD/CAM programs | I-2 Access CAD program options | I-3 Create designs with CAD section of CAD/CAM program | I-4 Demonstrate ability to use program functions | I-5 Process tool path data | | | | | | | | |



DAVIS TECHNOLOGIES
Participant

Charles Davis, Owner

**SKILLS AND KNOWLEDGE**

Communication Skills
Use Measurement Tools
Use Inspection Devices
Mathematical Skills
Reading/Writing Skills
Knowledge of Safety Regulations
Practice Safety in the Workplace
Organizational Skills
Knowledge of Company Policies/Procedures
Mechanical Aptitude
Ability to Comprehend Written/Verbal Instructions
Basic Knowledge of Fasteners
Ability to Work as Part of a Team
Converse in the Technical Language of the Trade
Knowledge of Occupational Opportunities
Knowledge of Employee/Employer Responsibilities
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Practice Quality-Consciousness in Performance of the Job


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FACILITATED BY:

MARY BENARD
Site Coordinator

LOUIS A. SPAIN, JR.
Consultant


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Punctuality
Dependability
Honesty
Neatness
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Responsible
Physical Ability
Professional
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Customer Relations
Personal Ethics

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Drill Presses
Vertical Mill with Attachments
Power Saws
Power Drills
Hydraulic/Arbor Press
Heat Treatment Equipment
Hardness Testing Equipment
Grinding Machines with Attachments
Welding Equipment (SMAW, GMAW, FCAW, Plasma)
CNC Machining Center and Turning Center
Gear Producing Machines with Attachments
Jig Boring Machines
Alignment/Calibration Tools
Coolant Recovery Equipment
Computer
Ventilation Equipment
Forklift
Personal Safety Equipment
Oxyacetylene Equipment
Tool Storage Equipment
Workbenches
Vises
Pedestal Grinders
Weld Test Equipment
Optical Comparator
Coordinate Measurement Machine
Hydraulic/Pneumatic Training Equipment
Electrical Training Equipment
Safety Training Equipment

**FUTURE TRENDS AND CONCERNS**

Statistical Process Control
Composites
Laser Machining
Advanced Computer Applications
Robotics
Environmental Concerns
Fiber Optic Controls
Automated Material Handling Equipment
Computer Integrated Manufacturing
ISO-9000



# COMPETENCY PROFILE

# CNC Machinist


**Prepared By**
**M.A.S.T.**
**Machine Tool Advanced Skills Technology Program**
**and**
**Consortia Partners**
**(V.199J40008)**


EATON LEONARD



BEST COPY AVAILABLE

**CNC MACHINIST**.... **program, edit, setup, and operate CNC lathes, mills and grinders to perform machining operations necessary to produce workpieces to referenced engineering standards.**

| Duties | Tasks | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| A Practice Safety | A-1 Use proper safety equipment | A-2 Identify proper clothing | A-3 State proper attitudes for safety | A-4 Handle chemicals properly | A-5 Identify fire hazards in machining | A-6 Demonstrate proper personal hygiene | A-7 Demonstrate proper laboratory cleaning | | | | | | |
| B Perform Measurements | B-1 Identify applications and limitations of measuring instruments | B-2 Demonstrate use of measuring instruments | | | | | | | | | | | |
| C Apply Mathematical Concepts | C-1 Perform mathematical computations with calculator | C-2 Calculate fractions and decimals with calculator | C-3 Convert Metric and US standard units of measure | C-4 Perform RPM calculations | C-5 Perform feed calculations | C-6 Perform depth of cut calculations | C-7 Perform thread cutting calculations | C-8 Perform tap drill calculations | C-9 Interpret reference tables related to machining | C-10 Apply Cartesian coordinate system in machining | C-11 Perform trigonometric calculations | C-12 Perform Pythagorean Theorem calculations | C-13 Perform polar trigonometry calculations |
| D Read Blueprints | D-1 Describe types of blueprint drawings | D-2 Describe blueprint dimensions | D-3 Interpret title, notes, revision and material information | D-4 Interpret blueprint drawings | | | | | | | | | |
| E Program CNC Machines & EDM | E-1 Demonstrate cutting tool identification and application | E-2 Identify and describe machine operation nomenclature | E-3 Identify and describe essentials of CNC systems | E-4 Identify and describe types of CNC hardware and software | E-5 Identify and describe machine axes and coordinate systems | E-6 Describe and interpret CNC coding systems | E-7 Write NC programs | E-8 Plan process for NC operations | | | | | |
| F Operate CNC Machines & EDM | F-1 Describe vertical machining process and safety | F-2 Describe vertical machining functions | F-3 Set-up and program operation of vertical machine | F-4 Demonstrate machining of objects on vertical machining center | F-5 Describe turning process, equipment, and safety | F-6 Describe turning center | F-7 Set-up and program operation of turning center | F-8 Demonstrate machining of objects on turning center | | | | | |
| G Use Computers | G-6 Demonstrate use of computer communication systems | | | | | | | | | | | | |
| H Use CAD/CAM Programs | H-1 Demonstrate understanding of CAD/CAM programs | H-2 Access CAD program options | H-3 Demonstrate ability to use program functions | H-4 Process tool path data | | | | | | | | | |

EATON LEONARD
Panel Members

Kevin Ragsdale
Machine Shop Manager

Johnny Berg
Director
Machine TQM/TSO Program

# COMPETENCY PROFILE APPROVAL FORM

San Diego City College
Center for Applied Comptetitive
Technologies (CACT)
1313 Twelfth Avenue
San Diego, CA 92101

Subject: Profile Approval

Re: CNC Machinist and Automated Equipment Technician Skills Inventory Surveys

Attn: Mary Benard

We have reviewed and approved the MAST Competency Profiles for the CNC Machinist and AET Technician positions. The information provided on these profiles accurately reflects the skills and tasks required to perform the duties of the jobs as discussed with Louis Spain and Mary Benard on 6/12/95.

We understand that the company will be identified as contributing to the development of the National Skill Standards for the CNC Machinist and AET Technician positions and look forward to receiving a copy of the profiles.

Judy Phillips
Manager, Human Resources
Eaton-Leonard

BEST COPY AVAILABLE

**SKILLS AND KNOWLEDGE**
Direct vs. Indirect Cost Understanding
Communication Skills
Use Measurement Tools
Use Inspection Devices
Mathematical Skills
Reading/Writing Skills
Knowledge of Safety Regulations
Practice Safety in the Workplace
Organizational Skills
Knowledge of Company Policies/Procedures
Mechanical Aptitude
Ability to Comprehend Written/Verbal Instructions
Basic Knowledge of Fasteners
Ability to Work as Part of a Team
Converse in the Technical Language of the Trade
Knowledge of Occupational Opportunities
Knowledge of Employee/Employer Responsibilities
Knowledge of Company Quality Assurance Activities
Practice Quality-Conscientiousness in Performance of the Job


**TEXAS STATE TECHNICAL COLLEGE WACO**
**MAST PROGRAM REPRESENTATIVES**

DR. HUGH ROGERS
Director

DR. JON BOTSFORD
Assistant Director

JOE PENICK
Project Coordinator

TERRY SAWMA
Research Coordinator

WALLACE PELTON
Site Coordinator

ROSE MARY TIMMONS
Senior Secretary/Statistician

**Furnished By:**

RICKY FLAK
Vice President - Operations

NICK NICHOLS
Manufacturing Manager - Diamond Products

STEVE BANKES
CNC Machinist

Texas State Technical College
Waco


**TRAITS AND ATTITUDES**
Cost Conscientiousness
Empowerment of Employees
Strong Work Ethic
Interpersonal Skills
Punctuality
Dependability
Honesty
Neatness
Safety Conscientious
Motivation
Responsible
Physical Ability
Professional
Trustworthy
Customer Relations
Personal Ethics

**TOOLS AND EQUIPMENT**
Machinist's Tools (e.g., calipers, dial indicators magnetic tool holders, etc.)
Measuring Tools
Power Tools
Metal Lathe with Attachments
Drill Presses
Vertical Mill with Attachments
Power Saws
Power Drills
Hydraulic/Arbor Press
Heat Treatment Equipment
Hardness Testing Equipment
Grinding Machines with Attachments
Welding Equipment (SMAW, GMAW, FCAW, Plasma)
CNC Machining Center and Turning Center
Gear Producing Machines with Attachments
Jig Boring Machines
Alignment/Calibration Tools
Coolant Recovery Equipment
Computer
Ventilation Equipment
Forklift
Personal Safety Equipment
Oxyacetylene Equipment
Tool Storage Equipment
Workbenches
Vises
Pedestal Grinders
Weld Test Equipment
Optical Comparator
Coordinate Measurement Machine
Hydraulic/Pneumatic Training Equipment
Electrical Training Equipment
Safety Training Equipment

**FUTURE TRENDS AND CONCERNS**
Statistical Process Control
Composites
Laser Machining
Advanced Computer Applications
Robotics
Environmental Concerns
Fiber Optic Controls
Automated Material Handling Equipment
Computer Integrated Manufacturing



# COMPETENCY PROFILE

# CNC Machinist


**Prepared By**
**M.A.S.T.**
**Machine Tool Advanced Skills Technology Program**
**and**
**Consortia Partners**
**(V.199J40008)**


Texas State Technical College
Waco

SMITH GEODIAMOND

**CNC MACHINIST**.... **program, edit, setup, and operate CNC lathes, mills and grinders to perform machining operations necessary to produce workpieces to referenced engineering standards.**

| Duties | Tasks | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| A Practice Safety | A-1 Follow safety manuals and all safety regulations/ requirements | A-2 Use protective equipment | A-3 Follow safe operating procedures for CNC machines | A-4 Maintain a clean and safe work environment | | | | | | | | | |
| B Apply Mathematical Concepts | B-1 Perform basic arithmetic functions | B-2 Locate machining points from a datum point | B-3 Inter-convert fractions/ decimals | | | | | | | | | | |
| C Interpret Engineering Drawings and Control Documents | C-1 Review blueprint notes and dimensions | C-2 Identify basic layout of drawings | C-3 Identify basic types of drawings | C-4 List the purpose of each type of drawing | C-5 Verify drawing elements | C-6 Practice geometric dimensioning and tolerancing (GD&T) methodology | C-7 Describe the relationship of engineering drawings to planning | C-8 Use standards to verify requirements | C-9 Analyze bill of materials (BOM) | | | | |
| D Perform Measurement/ Inspection | D-1 Identify types of measurement | D-2 Select proper measurement tools | D-3 Apply proper measuring technique | D-4 Use English standards of measurement | D-5 Perform measurements with hand held instruments | D-6 Perform measurements on surface plate | D-7 Perform inspections using stationary equipment | | | | | | |
| E Perform Conventional Machining Operations | E-1 Prepare and plan for machining operations | E-2 Use proper hand tools | E-3 Operate power saws | E-4 Operate drill presses | E-5 Operate vertical milling machines | E-6 Operate horizontal milling machines | E-7 Operate metal cutting lathes | E-8 Operate deburring tools | | | | | |
| F Perform CNC Machining Functions | F-1 Prepare and plan for CNC machining operations | F-2 Select and use CNC tooling systems | F-3 Program CNC machines | F-4 Edit CNC programs | F-5 Operate CNC machining centers (mills) | F-6 Operate CNC turning centers (lathes) | F-7 Download programs via network | | | | | | |
| G Use Computers | G-1 Use computer operating systems | G-2 Use computer inquiry systems | G-3 Use various computer applications | | | | | | | | | | |
| H Participate in Total Quality and SPC Activities | H-1 Define quality in manufacturing and explain importance | H-2 Perform Statistical Process Control (SPC) functions | H-3 Analyze machining problems and recommend solutions | | | | | | | | | | |





GROOMC PMS
MASTER (GRMP)

**SKILLS AND KNOWLEDGE**

Communication Skills
Use Measurement Tools
Use Inspection Devices
Mathematical Skills
Reading/Writing Skills
Knowledge of Safety Regulations
Practice Safety in the Workplace
Organizational Skills
Knowledge of Company Policies/Procedures
Mechanical Aptitude
Ability to Comprehend Written/Verbal Instructions
Basic Knowledge of Fasteners
Ability to Work as Part of a Team
Converse in the Technical Language of the Trade
Knowledge of Occupational Opportunities
Knowledge of Employee/Employer Responsibilities
Knowledge of Company Quality Assurance Activities
Practice Quality-Consciousness in Performance of the Job


**TEXAS STATE TECHNICAL COLLEGE WACO**
**MAST PROGRAM REPRESENTATIVES**

DR. HUGH K. ROGERS
Director

DR. JON BOTSFORD
Assistant Director

JOE PENICK
Project Coordinator

TERRY SAWMA
Research Coordinator

WALLACE PELTON
Site Coordinator

ROSE MARY TIMMONS
Senior Secretary/Statistician

**Furnished By:**

MARTY SCHMIDT
Senior Manufacturing Engineer and Systems Design Engineer

MICHAEL KON
Manufacturing Engineer and CNC Systems/Program Engineer


Texas State Technical College Waco



**TRAITS AND ATTITUDES**

Strong Work Ethic
Interpersonal Skills
Punctuality
Dependability
Honesty
Neatness
Safety Conscientious
Motivation
Responsible
Physical Ability
Professional
Trustworthy
Customer Relations
Personal Ethics

**TOOLS AND EQUIPMENT**

Machinist's Tools (e.g., calipers, dial indicators magnetic tool holders, etc.)
Measuring Tools
Power Tools
Metal Lathe with Attachments
Drill Presses
Vertical Mill with Attachments
Power Saws
Power Drills
Hydraulic/Arbor Press
Heat Treatment Equipment
Hardness Testing Equipment
Grinding Machines with Attachments
Welding Equipment (SMAW, GMAW, FCAW, Plasma)
CNC Machining Center and Turning Center
Gear Producing Machines with Attachments
Jig Boring Machines
Alignment/Calibration Tools
Coolant Recovery Equipment
Computer
Ventilation Equipment
Forklift
Personal Safety Equipment
Oxyacetylene Equipment
Tool Storage Equipment
Workbenches
Vises
Pedestal Grinders
Weld Test Equipment
Optical Comparator
Coordinate Measurement Machine
Hydraulic/Pneumatic Training Equipment
Electrical Training Equipment
Safety Training Equipment

**FUTURE TRENDS AND CONCERNS**

Statistical Process Control
Composites
Laser Machining
Advanced Computer Applications
Robotics
Environmental Concerns
Fiber Optic Controls
Automated Material Handling Equipment
Computer Integrated Manufacturing

# COMPETENCY PROFILE

# CNC Machinist

**Prepared By**
**M.A.S.T.**
**Machine Tool Advanced Skills Technology Program**
**and**
**Consortia Partners**
**(V.199J40008)**

Texas State Technical College Waco

LOCKHEED MARTIN

**CNC MACHINIST.... program, edit, setup, and operate CNC lathes, mills and grinders to perform machining operations necessary to produce workpieces to referenced engineering standards.**

| Duties | Tasks | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| A Practice Safety | A-1 Follow safety manuals and all safety regulations/ requirements | A-2 Use protective equipment | A-3 Follow safe operating procedures for CNC machines | A-4 Maintain a clean and safe work environment | | | | | | | | | |
| B Apply Mathematical Concepts | B-1 Perform basic arithmetic functions | B-2 Locate machining points from a datum point | B-3 Inter-convert fractions/ decimals | B-4 Inter-convert Metric/ English measurements | B-5 Perform basic trigonometric functions | B-6 Perform calculations for sine bar and sine plate | B-7 Use Machinery Handbook for reference | | | | | | |
| C Interpret Engineering Drawings and Control Documents | C-1 Review blueprint notes and dimensions | C-2 Identify basic layout of drawings | C-3 Identify basic types of drawings | C-4 List the purpose of each type of drawing | C-5 Verify drawing elements | C-6 Practice geometric dimensioning and tolerancing (GD&T) methodology | C-7 Describe the relationship of engineering drawings to planning | C-8 Use standards to verify requirements | C-9 Analyze bill of materials (BOM) | | | | |
| D Perform Measurement/ Inspection | D-1 Identify types of measurement | D-2 Select proper measurement tools | D-3 Apply proper measuring techniques | D-4 Use Metric and English standards of measurement | D-5 Perform measurements with hand held instruments | D-6 Perform measurements on surface plate | D-7 Perform inspections using stationary equipment | D-8 Perform inspection using coordinate measuring equipment and techniques | D-9 Understand and use cutting and special tools (i.e., fixtures, risers, jigs, etc.) | D-10 Understand the principles of metal cutting (speeds and feeds) | | | |
| E Perform Conventional Machining Operations | E-1 Prepare and plan for machining operations | E-2 Use proper hand tools | E-3 Set up/ operate power saws | E-4 Set up/ operate drill presses | E-5 Set up/ operate vertical milling machines | E-6 Set up/ operate horizontal milling machines | E-7 Set up/ operate metal cutting lathes | E-8 Set up/ operate surface grinders | E-9 Set up/ operate OD/ID grinders | E-10 Set up/ operate jig bore/jig grinding machines | E-11 Set up/ operate EDM | | |
| F Perform CNC Machining Functions | F-1 Prepare and plan for CNC machining operations | F-2 Select and use CNC tooling systems | F-3 Program CNC machines (including advanced features) | F-4 Edit CNC programs | F-5 Verify program with first part prove-in | F-6 Set up/ operate CNC machining centers (mills) | F-7 Set up/ operate CNC turning centers (lathes) | F-8 Set up/ operate 4 axis wire EDM | F-9 Set up/ operate CNC grinders | F-10 Set up/ operate CNC jig bore machines | F-11 Download programs via network | F-12 Understand cell concept manufacturing systems | F-13 MDI operate probe cycles |
| G Use Computers | G-1 Use computer operating systems | G-2 Use computer inquiry systems | G-3 Use various computer applications | | | | | | | | | | |
| H Use a CAM System for CNC Programming | H-1 Access a PC based CAM system | H-2 Input the tool information necessary to machine the part | H-3 Input geometric data for part construction | H-4 Generate CNC code | | | | | | | | | |
| I Participate in Total Quality and SPC Activities | I-1 Define quality in manufacturing and explain importance | I-2 Perform Statistical Process Control (SPC) functions | I-3 Analyze machining problems and recommend solutions | | | | | | | | | | |

**SKILLS AND KNOWLEDGE**
Communication Skills
Use Measurement Tools
Use Inspection Devices
Mathematical Skills
Reading/Writing Skills
Knowledge of Safety Regulations
Practice Safety in the Workplace
Organizational Skills
Knowledge of Company Policies/Procedures
Mechanical Aptitude
Ability to Comprehend Written/Verbal Instructions
Basic Knowledge of Fasteners
Ability to Work as Part of a Team
Converse in the Technical Language of the Trade
Knowledge of Occupational Opportunities
Knowledge of Employee/Employer Responsibilities
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**MAST PROGRAM REPRESENTATIVES**

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Director

JOE PENICK
Project Coordinator

TERRY SAWMA
Research Coordinator

WALLACE PELTON
Site Coordinator

ROSE MARY TIMMONS
Senior Secretary/Statistician

**Furnished By:**

ANDREW BROWN
Sr. Technical Specialist
Numerical Control Programming

VINCE GEBRIN
Specialist, Technical Training


Texas State Technical College Waco

**TRAITS AND ATTITUDES**
Strong Work Ethic
Interpersonal Skills
Punctuality
Dependability
Honesty
Neatness
Safety Conscientious
Motivation
Responsible
Physical Ability
Professional
Trustworthy
Customer Relations
Personal Ethics

**TOOLS AND EQUIPMENT**
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Grinding Machines with Attachments
Welding Equipment (SMAW, GMAW, FCAW, Plasma)
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Ventilation Equipment
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Personal Safety Equipment
Oxyacetylene Equipment
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Weld Test Equipment
Optical Comparator
Coordinate Measurement Machine
Hydraulic/Pneumatic Training Equipment
Electrical Training Equipment
Safety Training Equipment

**FUTURE TRENDS AND CONCERNS**
Statistical Process Control
Composites
Laser Machining
Advanced Computer Applications
Robotics
Environmental Concerns
Fiber Optic Controls
Automated Material Handling Equipment
Computer Integrated Manufacturing
Machine Tool Simulation
Adaptive Control
Closed Loop Programming/Probing



# COMPETENCY PROFILE

# CNC Machinist

**Prepared By**
**M.A.S.T.**
**Machine Tool Advanced Skills**
**Technology Program**
**and**
**Consortia Partners**
**(V.199J40008)**

Texas State Technical College Waco

**MCDONNELL DOUGLAS**



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**CNC MACHINIST** .... program, edit, setup, and operate CNC lathes, mills and grinders to perform machining operations necessary to produce workpieces to referenced engineering standards.

| Duties | Tasks | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| A Practice Safety | A-1 Follow safety manuals and all safety regulations/ requirements | A-2 Use protective equipment | A-3 Follow safe operating procedures for CNC machines | A-4 Maintain a clean and safe work environment | | | | | | | | | |
| B Apply Mathematical Concepts | B-1 Perform basic arithmetic functions | B-2 Locate machining points from a datum point | B-3 Inter-convert fractions/ decimals | B-4 Inter-convert Metric/ English measurements | B-5 Perform basic trigonometric functions | B-6 Perform calculations for sine bar, sine plate and tapers | B-7 Perform calculus functions | | | | | | |
| C Interpret Engineering Drawings and Control Documents | C-1 Review blueprint notes and dimensions | C-2 Identify basic layout of drawings | C-3 Identify basic types of drawings | C-4 List the purpose of each type of drawing | C-5 Verify drawing elements | C-6 Understand the principles of geometric dimensioning and tolerancing (GD&T) and ISO9000 | C-7 Describe the relationship of engineering drawings to planning | C-8 Use standards to verify requirements | C-9 Analyze bill of materials (BOM) | C-10 Demonstrate knowledge of tool design and concepts | C-11 Perform benchmark activities for Baldridge Award | | |
| D Perform Measurement/ Inspection | D-1 Identify types of measurement | D-2 Select proper measurement tools | D-3 Apply proper measuring techniques | D-4 Use Metric and English standards of measurement | D-5 Perform measurements with hand held instruments | D-6 Perform measurements on surface plate | D-7 Perform inspections using stationary equipment | D-8 Perform in-process probing functions | | | | | |
| E Perform Conventional Machining Operations | E-1 Prepare and plan for machining operations | E-2 Use proper hand tools | E-3 Operate power saws | E-4 Operate drill presses | E-5 Operate vertical milling machines | E-6 Operate horizontal milling machines | E-7 Operate metal cutting lathes | | | | | | |
| F Perform CNC Machining Functions | F-1 Prepare and plan for CNC machining operations | F-2 Select and use CNC tooling systems | F-3 Program CNC machines | F-4 Operate CNC machining centers (mills) | F-5 Operate CNC turning centers (lathes) | F-6 Operate electrical discharge machines | F-7 Operate CNC grinders | F-8 Operate CNC jig bore machines | F-9 Upload and download programs via network | F-10 Know parmetric programming | F-11 Design holding fixtures and sequence locations for high speed machining | F-12 Know high speed programming techniques | |
| G Use Computers | G-1 Use computer operating systems | G-2 Use computer inquiry systems | G-3 Use various computer applications | G-4 Use PC based CAD systems | G-5 Write computer programs | | | | | | | | |
| H Use a CAM System for CNC Programming | H-1 Use a PC based CAM system | H-2 Input the tool information necessary to machine the part | H-3 Input geometric data for part construction | H-4 Generate CNC code | | | | | | | | | |
| I Participate in Total Quality and SPC Activities | I-1 Define quality in manufacturing and explain importance | I-2 Perform Statistical Process Control (SPC) functions | I-3 Analyze machining problems and recommend solutions | I-4 Provide documentation for Baldridge Award | | | | | | | | | |

**SKILLS AND KNOWLEDGE**

Communication Skills
Use Measurement Tools
Use Inspection Devices
Mathematical Skills
Reading/Writing Skills
Knowledge of Safety Regulations
Practice Safety in the Workplace
Organizational Skills
Knowledge of Company Policies/Procedures
Mechanical Aptitude
Ability to Comprehend Written/Verbal Instructions
Basic Knowledge of Fasteners
Ability to Work as Part of a Team
Converse in the Technical Language of the Trade
Knowledge of Occupational Opportunities
Knowledge of Employee/Employer Responsibilities
Knowledge of Company Quality Assurance Activities
Practice Quality-Consciousness in Performance of the Job
Quality Tools
Torch Operations
B-Adjusting Flame
B-Tip Selection
Deming Principles (Program 2000)
All Trained Top Down


**SAN DIEGO CITY COLLEGE**
**CENTER FOR APPLIED COMPETITIVE TECHNOLOGIES (CACT)**
**MAST PROGRAM REPRESENTATIVES**

DR. JOAN A. STEPSIS
Dean/Director-CACT

JOHN BOLLINGER
Subject Matter Expert

FACILITATED BY:

MARY BENARD
Site Coordinator

LOUIS A. SPAIN, JR.
Consultant

**TRAITS AND ATTITUDES**

| | |
|---|---|
| Strong Work Ethic | Motivation |
| Interpersonal Skills | Responsible |
| Punctuality | Physical Ability |
| Dependability | Professional |
| Honesty | Trustworthy |
| Neatness | Customer Relations |
| Safety Conscientious | Personal Ethics |

**TOOLS AND EQUIPMENT**

Machinist's Tools (e.g., calipers, dial indicators magnetic tool holders, etc.)
Measuring Tools
Power Tools
Metal Lathe with Attachments
Drill Presses
Vertical Mill with Attachments
Power Saws
Power Drills
Hydraulic/Arbor Press
Heat Treatment Equipment
Hardness Testing Equipment
Grinding Machines with Attachments
Welding Equipment (SMAW, GMAW, FCAW, Plasma)
CNC Machining Center and Turning Center
Gear Producing Machines with Attachments
Jig Boring Machines
Alignment/Calibration Tools
Coolant Recovery Equipment
Computer
Ventilation Equipment
Forklift
Personal Safety Equipment
Oxyacetylene Equipment
Tool Storage Equipment
Workbenches
Vises
Pedestal Grinders
Weld Test Equipment
Optical Comparator
Coordinate Measurement Machine
Hydraulic/Pneumatic Training Equipment
Electrical Training Equipment
Safety Training Equipment
Torches
Tips
Plasma Heads
Meters
Gauges

**FUTURE TRENDS AND CONCERNS**

Statistical Process Control
Composites
Laser Machining in Sheet Metal
Advanced Computer Applications
Robotics
Environmental Concerns
Fiber Optic Controls
Automated Material Handling Equipment
Computer Integrated Manufacturing
Water Jet in Sheet Metal
Plasma



# COMPETENCY PROFILE

# CNC Machinist

**Prepared By**
**M.A.S.T.**
**Machine Tool Advanced Skills Technology Program**
**and**
**Consortia Partners**
**(V.199J40008)**

**CNC MACHINIST**.... **program, edit, setup, and operate CNC lathes, mills and grinders to perform machining operations necessary to produce workpieces to referenced engineering standards.**

**Duties** ← **Tasks** →

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **A** | **Practice Safety** | A-1 Use proper safety equipment | A-2 Identify proper clothing | A-3 State proper attitudes for safety | A-4 Handle chemicals properly | A-5 Identify fire hazards in machining | A-6 Demonstrate proper personal hygene | A-7 Demonstrate proper laboratory cleaning | | | | | |
| **B** | **Perform Measurements** | B-1 Identify applications and limitations of measuring instruments | B-2 Demonstrate use of measuring instruments | | | | | | | | | | |
| **C** | **Apply Mathematical Concepts** | C-1 Perform mathematical computations with calculator | C-2 Calculate fractions and decimals with calculator | C-3 Perform RPM calculations | C-4 Perform feed calculations | C-5 Perform depth of cut calculations | C-6 Perform thread cutting calculations | C-7 Perform tap drill calculations | C-8 Interpret reference tables related to machining | C-9 Apply Cartesian coordinate system in machining | C-10 Perform trigonometric calculations | C-11 Perform Pythagorean Theorem calculations | C-12 Perform polar trigonometry calculations |
| **D** | **Read Blueprints** | D-1 Describe types of blueprint drawings | D-2 Describe blueprint dimensions | D-3 Interpret title, notes, revision and material information | D-4 Interpret blueprint drawings | | | | | | | | |
| **E** | **Program CNC Machines & EDM** | E-1 Demonstrate cutting tool identification and application | E-2 Identify and describe machine operation nomenclature | E-3 Identify and describe essentials of CNC systems | E-4 Identify and describe types of CNC hardware and software | E-5 Identify and describe machine axes and coordinate systems | E-6 Describe and interpret CNC coding systems | E-7 Write NC programs | E-8 Plan process for NC operations | E-9 Demonstrate use of electronic discharge machine (EDM) | | | |
| **F** | **Operate CNC Machines & EDM** | F-1 Describe vertical machining process and safety | F-2 Describe vertical machining functions | F-3 Set-up and program operation of vertical machine | F-4 Demonstrate machining of objects on vertical machining center | F-5 Perform advance EDM operations | F-6 Describe turning process, equipment and, safety | F-7 Describe turning center | F-8 Set-up and program operation of turning center | F-9 Demonstrate machining of objects on turning center | | | |
| **G** | **Use Computers** | G-1 Demonstrate use of computer hardware | G-2 Select/use computer operating systems | G-3 Demonstrate use of basic DOS commands | G-4 Demonstrate use of Windows and Windows NT commands | G-5 Demonstrate use of MACROS in Windows and Windows NT programs | G-6 Demonstrate use of computer communication systems | | | | | | |
| **H** | **Use CNC Verification Programs** | H-1 Identify CNC verification software programs | H-2 Program and create CNC verification using program icons | H-3 Program CNC verification using pull-down menus | | | | | | | | | |
| **I** | **Use CAD/ CAM Programs** | I-1 Demonstrate understanding of CAD/CAM programs | I-2 Access CAD program options | I-3 Create designs with CAD section of CAD/CAM program | I-4 Demonstrate ability to use program functions | I-5 Process tool path data | | | | | | | |

NASSCO
Panel Members

Charles I. Zigelman, CFPIM
Manager
Fabrication

James L. Clark
Maintenance General Foreman

Marcus Lopez
Machine Operator

Sylvestre DeLaTorres
Cutting Machine Operator

**SKILLS AND KNOWLEDGE**
Communication Skills
Use Measurement Tools
Use Inspection Devices
Mathematical Skills
Reading/Writing Skills
Knowledge of Safety Regulations
Practice Safety in the Workplace
Organizational Skills
Knowledge of Company Policies/Procedures
Mechanical Aptitude
Ability to Comprehend Written/Verbal Instructions
Basic Knowledge of Fasteners
Ability to Work as Part of a Team
Converse in the Technical Language of the Trade
Knowledge of Occupational Opportunities
Knowledge of Employee/Employer Responsibilities
Knowledge of Company Quality Assurance Activities
Practice Quality-Consciousness in Performance of the Job

**TRAITS AND ATTITUDES**
Strong Work Ethic
Interpersonal Skills
Punctuality
Dependability
Honesty
Neatness
Safety Conscientious
Motivation
Responsible
Physical Ability
Professional
Trustworthy
Customer Relations
Personal Ethics

**TOOLS AND EQUIPMENT**
Machinist's Tools (e.g., calipers, dial indicators magnetic tool holders, etc.)
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Power Tools
Metal Lathe with Attachments
Drill Presses
Vertical Mill with Attachments
Power Saws
Power Drills
Hydraulic/Arbor Press
Heat Treatment Equipment
Hardness Testing Equipment
Grinding Machines with Attachments
Welding Equipment (SMAW, GMAW, FCAW, Plasma)
CNC Machining Center and Turning Center
Gear Producing Machines with Attachments
Jig Boring Machines
Alignment/Calibration Tools
Coolant Recovery Equipment
Computer
Ventilation Equipment
Forklift
Personal Safety Equipment
Oxyacetylene Equipment
Tool Storage Equipment
Workbenches
Vises
Pedestal Grinders
Weld Test Equipment
Optical Comparator
Coordinate Measurement Machine
Hydraulic/Pneumatic Training Equipment
Electrical Training Equipment
Safety Training Equipment

**FUTURE TRENDS AND CONCERNS**
Statistical Process Control
Composites
Laser Machining
Advanced Computer Applications
Robotics
Environmental Concerns
Fiber Optic Controls
Automated Material Handling Equipment
Computer Integrated Manufacturing


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MAST PROGRAM REPRESENTATIVES

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Dean/Director-CACT

JOHN BOLLINGER
Subject Matter Expert

FACILITATED BY:

MARY BENARD
Site Coordinator

LOUIS A. SPAIN, JR.
Consultant




# COMPETENCY PROFILE

# CNC Machinist

**Prepared By**
**M.A.S.T.**
**Machine Tool Advanced Skills Technology Program**
**and**
**Consortia Partners**
**(V.199J40008)**

ROHR



BEST COPY AVAILABLE

**CNC MACHINIST**.... **program, edit, setup, and operate CNC lathes, mills and grinders to perform machining operations necessary to produce workpieces to referenced engineering standards.**

| Duties | Tasks | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| A Practice Safety | A-1 Use proper safety equipment | A-2 Identify proper clothing | A-3 State proper attitudes for safety | A-4 Handle chemicals properly | A-5 Identify fire hazards in machining | A-6 Demonstrate proper personal hygiene | A-7 Demonstrate proper laboratory cleaning | | | | | | |
| B Perform Measurements | B-1 Identify applications and limitations of measuring instruments | B-2 Demonstrate use of measuring instruments | | | | | | | | | | | |
| C Apply Mathematical Concepts | C-1 Perform mathematical computations with calculator | C-2 Calculate fractions and decimals with calculator | C-3 Perform RPM calculations | C-4 Perform feed calculations | C-5 Perform depth of cut calculations | C-6 Perform thread cutting calculations | C-7 Perform tap drill calculations | C-8 Interpret reference tables related to machining | C-9 Apply Cartesian coordinate system in machining | C-10 Perform trigonometric calculations | C-11 Perform Pythagorean Theorem calculations | C-12 Perform polar trigonometry calculations | |
| D Read Blueprints | D-1 Describe types of blueprint drawings | D-2 Describe blueprint dimensions | D-3 Interpret title, notes, revision and material information | D-4 Interpret blueprint drawings | | | | | | | | | |
| E Program CNC Machines & EDM | E-1 Demonstrate cutting tool identification and application | E-2 Identify and describe machine operation nomenclature | E-3 Identify and describe essentials of CNC systems | E-4 Identify and describe types of CNC hardware and software | E-5 Identify and describe machine axes and coordinate systems | E-6 Describe and interpret CNC coding systems | E-7 Write NC programs | E-8 Plan process for NC operations | E-9 Demonstrate use of electronic discharge machine (EDM) | | | | |
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| I Use CAD/CAM Programs | I-1 Demonstrate understanding of CAD/CAM programs | I-2 Access CAD program options | I-3 Create designs with CAD section of CAD/CAM program | I-4 Demonstrate ability to use program functions | I-5 Process tool path data | | | | | | | | |

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ROHR
Panel Members

Tim Burke
General Supervisor
NC Machine Shop/NC Programming

Larry Crano
NC Engineer Sr.

Jim McKechnie
Manager
Machine Shop and Tool Manufacturing

202

# COMPETENCY PROFILE APPROVAL FORM

San Diego City College
Center for Applied Comptetitive
Technologies (CACT)
1313 Twelfth Avenue
San Diego, CA 92101

Subject: Profile Approval

Re: CNC Machinist and Automated Equipment Technician Skills Inventory Surveys

Attn: Mary Benard

We have reviewed and approved the MAST Competency Profiles for the CNC Machinist and AET Technician positions. The information provided on these profiles accurately reflects the skills and tasks required to perform the duties of the jobs as discussed with Louis Spain and Mary Benard on 6/7/95.

We understand that the company will be identified as contributing to the development of the National Skill Standards for the CNC Machinist and AET Technician positions and look forward to receiving a copy of the profiles.

Jim McKechnie
Manager
Machine Shop and Tool Manufacturing
Rohr, Inc.

**SKILLS AND KNOWLEDGE**

Communication Skills
Use Measurement Tools
Use Inspection Devices
Mathematical Skills
Reading/Writing Skills
Knowledge of Safety Regulations
Practice Safety in the Workplace
Organizational Skills
Knowledge of Company Policies/Procedures
Mechanical Aptitude
Ability to Comprehend Written/Verbal Instructions
Basic Knowledge of Fasteners
Ability to Work as Part of a Team
Converse in the Technical Language of the Trade
Knowledge of Occupational Opportunities
Knowledge of Employee/Employer Responsibilities
Knowledge of Company Quality Assurance Activities
Practice Quality-Consciousness in Performance of the Job
Presentations
Problem-Solving
Time Management
Process Simplification
Public Speaking


SAN DIEGO CITY COLLEGE
CENTER FOR APPLIED COMPETITIVE TECHNOLOGIES (CACT)
MAST PROGRAM REPRESENTATIVES

DR. JOAN A. STEPSIS
Dean/Director-CACT

JOHN BOLLINGER
Subject Matter Expert

FACILITATED BY:

MARY BENARD
Site Coordinator

LOUIS A. SPAIN, JR.
Consultant


**TRAITS AND ATTITUDES**

Strong Work Ethic
Interpersonal Skills
Punctuality
Dependability
Honesty
Neatness
Safety Conscientious
Motivation
Responsible
Physical Ability
Professional
Trustworthy
Customer Relations
Personal Ethics
Pride

**TOOLS AND EQUIPMENT**

Machinist's Tools (e.g., calipers, dial indicators magnetic tool holders, etc.)
Measuring Tools
Power Tools
Metal Lathe with Attachments
Drill Presses
Vertical Mill with Attachments
Power Saws
Power Drills
Hydraulic/Arbor Press
Heat Treatment Equipment
Hardness Testing Equipment
Grinding Machines with Attachments
Welding Equipment (SMAW, GMAW, FCAW, Plasma)
CNC Machining Center and Turning Center
Gear Producing Machines with Attachments
Jig Boring Machines
Alignment/Calibration Tools
Coolant Recovery Equipment
Computer
Ventilation Equipment
Forklift
Personal Safety Equipment
Oxyacetylene Equipment
Tool Storage Equipment
Workbenches
Vises
Pedestal Grinders
Weld Test Equipment
Optical Comparator
Coordinate Measurement Machine
Hydraulic/Pneumatic Training Equipment
Electrical Training Equipment
Safety Training Equipment
Electronic Probes (on machine tools)

**FUTURE TRENDS AND CONCERNS**

Statistical Process Control
Composites
Laser Machining
Advanced Computer Applications
Robotics
Environmental Concerns
Fiber Optic Controls
Automated Material Handling Equipment
Computer Integrated Manufacturing
JIT
ISO 9000
Feature Based Design (Standardization)
Standardized Parts
MRP



## COMPETENCY PROFILE

# CNC Machinist


**Prepared By**
**M.A.S.T.**
**Machine Tool Advanced Skills Technology Program**
**and**
**Consortia Partners**
**(V.199J40008)**


# Solar® Turbines

***A Caterpillar Company***

**CNC MACHINIST**.... **program, edit, setup, and operate CNC lathes, mills and grinders to perform machining operations necessary to produce workpieces to referenced engineering standards.**

| Duties | Tasks | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| A — Practice Safety | A-1 Use proper safety equipment | A-2 Identify proper clothing | A-3 State proper attitudes for safety | A-4 Handle chemicals properly | A-5 Identify fire hazards in machining | A-6 Demonstrate proper personal hygiene | A-7 Demonstrate proper laboratory cleaning | | | | | | |
| B — Perform Measurements | B-1 Identify applications and limitations of measuring instruments | B-2 Demonstrate use of measuring instruments | | | | | | | | | | | |
| C — Apply Mathematical Concepts | C-1 Perform mathematical computations with calculator | C-2 Calculate fractions and decimals with calculator | C-3 Perform RPM calculations | C-4 Perform feed calculations | C-5 Perform depth of cut calculations | C-6 Perform thread cutting calculations | C-7 Perform tap drill calculations | C-8 Interpret reference tables related to machining | C-9 Apply Cartesian coordinate system in machining | C-10 Perform trigonometric calculations | C-11 Perform Pythagorean Theorem calculations | C-12 Perform polar trigonometry calculations | |
| D — Read Blueprints | D-1 Describe types of blueprint drawings | D-2 Describe blueprint dimensions | D-3 Interpret title, notes, revision and material information | D-4 Interpret blueprint drawings | | | | | | | | | |
| E — Program CNC Machines & EDM | E-1 Demonstrate cutting tool identification and application | E-2 Identify and describe machine operation nomenclature | E-3 Identify and describe essentials of CNC systems | E-4 Identify and describe types of CNC hardware and software | E-5 Identify and describe machine axes and coordinate systems | E-6 Describe and interpret CNC coding systems | E-7 Write NC programs | E-8 Plan process for NC operations | E-9 Demonstrate use of electronic discharge machine (EDM) | | | | |
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| I — Use CAD/CAM Programs | I-1 Demonstrate understanding of CAD/CAM programs | I-2 Access CAD program options | I-3 Create designs with CAD section of CAD/CAM program | I-4 Demonstrate ability to use program functions | I-5 Process tool path data | | | | | | | | |

Solar Turbines
Panel Members

Richard I. Seaver, CMfgE
Principal, Numerical Control Engineer

John J. Kapusnik
Manufacturing Engineer

John A. Turnage, CMfgE
Manufacturing Engineer Sr., NC/CNC

Jim Sperling
Manager, Manufacturing Process Development

**SKILLS AND KNOWLEDGE**

Communication Skills
Use Measurement Tools
Use Inspection Devices
Mathematical Skills
Reading/Writing Skills
Knowledge of Safety Regulations
Practice Safety in the Workplace
Organizational Skills
Knowledge of Company Policies/Procedures
Mechanical Aptitude
Ability to Comprehend Written/Verbal Instructions
Basic Knowledge of Fasteners
Ability to Work as Part of a Team
Converse in the Technical Language of the Trade
Knowledge of Occupational Opportunities
Knowledge of Employee/Employer Responsibilities
Knowledge of Company Quality Assurance Activities
Practice Quality-Consciousness in Performance of the Job

**TRAITS AND ATTITUDES**

Strong Work Ethic
Interpersonal Skills
Punctuality
Dependability
Honesty
Neatness
Safety Conscientious
Motivation
Responsible
Physical Ability
Professional
Trustworthy
Customer Relations
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**TOOLS AND EQUIPMENT**

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Gear Producing Machines with Attachments
Jig Boring Machines
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Coolant Recovery Equipment
Computer
Ventilation Equipment
Forklift
Personal Safety Equipment
Oxyacetylene Equipment
Tool Storage Equipment
Workbenches
Vises
Pedestal Grinders
Weld Test Equipment
Hydraulic/Pneumatic Training Equipment
Electrical Training Equipment
Safety Training Equipment

**FUTURE TRENDS AND CONCERNS**

Statistical Process Control
Laser Machining
Advanced Computer Applications
Robotics
Environmental Concerns
DNC
Automated Material Handling Equipment
Computer Integrated Manufacturing


**SAN DIEGO CITY COLLEGE**
**CENTER FOR APPLIED COMPETITIVE TECHNOLOGIES (CACT)**
**MAST PROGRAM REPRESENTATIVES**

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Dean/Director-CACT

JOHN BOLLINGER
Subject Matter Expert

FACILITATED BY:

MARY BENARD
Site Coordinator

LOUIS A. SPAIN, JR.
Consultant




# COMPETENCY PROFILE

# CNC Machinist

**Prepared By**
**M.A.S.T.**
**Machine Tool Advanced Skills Technology Program**
**and**
**Consortia Partners**
**(V.199J40008)**

SOUTHWEST FABRICATORS



BEST COPY AVAILABLE

**CNC MACHINIST**.... **program, edit, setup, and operate CNC lathes, mills and grinders to perform machining operations necessary to produce workpieces to referenced engineering standards.**

| Duties | Tasks | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| A Practice Safety | A-1 Use proper safety equipment | A-2 Identify proper clothing | A-3 State proper attitudes for safety | A-4 Handle chemicals properly | A-5 Identify fire hazards in machining | A-6 Demonstrate proper personal hygiene | A-7 Demonstrate proper laboratory cleaning | | | | | | |
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SOUTHWEST FABRICATORS
Panel Members

Dennis Richardson
Production Supervisor

Corey Buren
Punch Press Operator

# COMPETENCY PROFILE APPROVAL FORM

San Diego City College
Center for Applied Comptetitive
Technologies (CACT)
1313 Twelfth Avenue
San Diego, CA 92101

Subject: Profile Approval

Re: CNC Machinist and Automated Equipment Technician Skills Inventory Surveys

Attn: Mary Benard

We have reviewed and approved the MAST Competency Profiles for the CNC Machinist and AET Technician positions. The information provided on these profiles accurately reflects the skills and tasks required to perform the duties of the jobs as discussed with Louis Spain and Mary Benard on 6/8/95.

We understand that the company will be identified as contributing to the development of the National Skill Standards for the CNC Machinist and AET Technician positions and look forward to receiving a copy of the profiles.

William Borinski
Senior Estimator
Southwest Fabricators

Dennis Mindnich
Director of Operations
Southwest Fabricators

**SKILLS AND KNOWLEDGE**

Communication Skills
Use Measurement Tools
Use Inspection Devices
Mathematical Skills
Reading/Writing Skills
Knowledge of Safety Regulations
Practice Safety in the Workplace
Organizational Skills
Knowledge of Company Policies/Procedures
Mechanical Aptitude
Ability to Comprehend Written/Verbal Instructions
Basic Knowledge of Fasteners
Ability to Work as Part of a Team
Converse in the Technical Language of the Trade
Knowledge of Occupational Opportunities
Knowledge of Employee/Employer Responsibilities
Knowledge of Company Quality Assurance Activities
Practice Quality-Consciousness in Performance of the Job


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LOUIS A. SPAIN, JR.
Consultant


**TRAITS AND ATTITUDES**

Strong Work Ethic
Interpersonal Skills
Punctuality
Dependability
Honesty
Neatness
Safety Conscientious
Motivation
Responsible
Physical Ability
Professional
Trustworthy
Customer Relations
Personal Ethics
Candor

Knows how to make things
Has a feel for machines
Affinity for a shop
Pass a 6-8 hour skills test,
in 3-4 different departments

**TOOLS AND EQUIPMENT**

Machinist's Tools (e.g., calipers, dial indicators magnetic tool holders, etc.)
Measuring Tools
Power Tools
Metal Lathe with Attachments
Drill Presses
Vertical Mill with Attachments
Power Saws
Power Drills
Hydraulic/Arbor Press
Heat Treatment Equipment
Hardness Testing Equipment
Grinding Machines with Attachments
Welding Equipment (SMAW, GMAW, FCAW, Plasma)
CNC Machining Center and Turning Center
Gear Producing Machines with Attachments
Jig Boring Machines
Alignment/Calibration Tools
Coolant Recovery Equipment
Computer
Ventilation Equipment
Forklift
Personal Safety Equipment
Oxyacetylene Equipment
Tool Storage Equipment
Workbenches
Vises
Pedestal Grinders
Weld Test Equipment
Optical Comparator
Coordinate Measurement Machine
Hydraulic/Pneumatic Training Equipment
Electrical Training Equipment
Safety Training Equipment

**FUTURE TRENDS AND CONCERNS**

Statistical Process Control
Composites
Laser Machining
Advanced Computer Applications
Robotics
Environmental Concerns
Fiber Optic Controls
Automated Material Handling Equipment
Computer Integrated Manufacturing



## COMPETENCY PROFILE

# CAD/CAM and CNC Technician

**Prepared By**
**M.A.S.T.**
**Machine Tool Advanced Skills**
**Technology Program**
**and**
**Consortia Partners**
**(V.199J40008)**

Taylor

**CAD/CAM and CNC Technician .... program, edit, setup, and operate CNC lathes, mills and grinders to perform machining operations necessary to produce workpieces to referenced engineering standards.**

| Duties | Tasks | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| A Practice Safety | A-1 Use proper safety equipment | A-2 Identify proper clothing | A-3 State proper attitudes for safety | A-4 Handle chemicals properly | A-5 Identify fire hazards in machining | A-6 Demonstrate proper personal hygiene | A-7 Demonstrate proper laboratory cleaning | | | | | | |
| B Perform Measurements | B-1 Identify applications and limitations of measuring instruments | B-2 Demonstrate use of measuring instruments | | | | | | | | | | | |
| C Apply Mathematical Concepts | C-1 Perform mathematical computations with calculator | C-2 Calculate fractions and decimals with calculator | C-3 Perform RPM calculations | C-4 Perform feed calculations | C-5 Perform depth of cut calculations | C-6 Perform thread cutting calculations | C-7 Perform tap drill calculations | C-8 Interpret reference tables related to machining | C-9 Apply Cartesian coordinate system in machining | C-10 Perform Pythagorean Theorem calculations | C-11 Perform polar trigonometry calculations | | |
| D Read Blueprints | D-1 Describe types of blueprint drawings | D-2 Describe blueprint dimensions | | | | | | | | | | | |
| E Program CNC Machines & EDM | E-1 Demonstrate cutting tool identification and application | E-2 Identify and describe machine operation nomenclature | E-3 Identify and describe essentials of CNC systems | E-4 Identify and describe types of CNC hardware and software | E-5 Identify and describe machine axes and coordinate systems | E-6 Describe and interpret CNC coding systems | E-7 Write NC programs | E-8 Plan process for NC operations | | | | | |
| F Operate CNC Machines & EDM | F-1 Describe vertical machining process and safety | F-2 Describe vertical machining functions | F-3 Set-up and program operation of vertical machine | F-4 Deomonstrate machining of objects on vertical machining center | | | | | | | | | |
| G Use Computers | G-1 Demonstrate use of computer hardware | G-2 Select/use computer operating systems | G-3 Demonstrate use of basic DOS commands | G-4 Demonstrate use of Windows and Windows NT commands | G-5 Demonstrate use of computer communication systems | | | | | | | | |
| H Use CAD/CAM Programs | H-1 Demonstrate understanding of CAD/CAM programs | H-2 Access CAD program options | H-3 Create designs with CAD section of CAD/CAM program | H-4 Demonstrate ability to use program functions | H-5 Process tool path data | | | | | | | | |

TAYLOR GUITARS
Panel Member

Robert Taylor, President





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# COMPETENCY PROFILE APPROVAL FORM

San Diego City College
Center for Applied Comptetitive
Technologies (CACT)
1313 Twelfth Avenue
San Diego, CA 92101

Subject: Profile Approval

Re: CNC Machinist Skills Inventory Survey

Attn: Mary Benard

I have reviewed and approved the MAST Competency Profile for the CNC Machinist position. The information provided on this profile accurately reflects the skills and tasks required to perform the duties of the job as discussed with Louis Spain and Mary Benard on 6/25/95.

I understand that the company will be identified as contributing to the development of the National Skill Standards for the CNC Machinist and Technician positions and look forward to receiving a copy of the profile.

Robert Taylor
President
Taylor Guitars

**SKILLS AND KNOWLEDGE**

Communication Skills
Use Measurement Tools
Use Inspection Devices
Mathematical Skills
Reading/Writing Skills
Knowledge of Safety Regulations
Practice Safety in the Workplace
Organizational Skills
Knowledge of Company Policies/Procedures
Mechanical Aptitude
Ability to Comprehend Written/Verbal Instructions
Basic Knowledge of Fasteners
Ability to Work as Part of a Team
Converse in the Technical Language of the Trade
Knowledge of Occupational Opportunities
Knowledge of Employee/Employer Responsibilities
Knowledge of Company Quality Assurance Activities
Practice Quality-Consciousness in Performance of the Job


SAN DIEGO CITY COLLEGE
CENTER FOR APPLIED COMPETITIVE TECHNOLOGIES (CACT)
MAST PROGRAM REPRESENTATIVES

DR. JOAN A. STEPSIS
Dean/Director-CACT

JOHN BOLLINGER
Subject Matter Expert

FACILITATED BY:

MARY BENARD
Site Coordinator

LOUIS A. SPAIN, JR.
Consultant


**TRAITS AND ATTITUDES**

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Interpersonal Skills
Punctuality
Dependability
Honesty
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Jig Boring Machines
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Coolant Recovery Equipment
Computer
Ventilation Equipment
Forklift
Personal Safety Equipment
Oxyacetylene Equipment
Tool Storage Equipment
Workbenches
Vises
Pedestal Grinders
Weld Test Equipment
Optical Comparator
Coordinate Measurement Machine
Hydraulic/Pneumatic Training Equipment
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Advanced Computer Applications
Robotics
Environmental Concerns
Fiber Optic Controls
Automated Material Handling Equipment
Computer Integrated Manufacturing



## COMPETENCY PROFILE

# CAD/CAM and CNC Technician


**Prepared By**
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**(V.199J40008)**


TELEDYNE RYAN AERONAUTICAL

**CAD/CAM and CNC Technician**.... program, edit, setup, and operate CNC lathes, mills and grinders to perform machining operations necessary to produce workpieces to referenced engineering standards.

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| B Perform Measurements | B-1 Identify applications and limitations of measuring instruments | B-2 Demonstrate use of measuring instruments | | | | | | | | | | | |
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| D Read Blueprints | D-1 Describe types of blueprint drawings | D-2 Describe blueprint dimensions | D-3 Interpret title, notes, revision and material information | D-4 Interpret blueprint drawings | | | | | | | | | |
| E Program CNC Machines & EDM | E-1 Demonstrate cutting tool identification and application | E-2 Identify and describe machine operation nomenclature | E-3 Identify and describe essentials of CNC systems | E-4 Identify and describe types of CNC hardware and software | E-5 Identify and describe machine axes and coordinate systems | E-6 Describe and interpret CNC coding systems | E-7 Write NC programs | E-8 Plan process for NC operations | | | | | |
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| G Use Computers | G-1 Demonstrate use of computer hardware | G-2 Select/use computer operating systems | G-3 Demonstrate use of basic DOS commands | G-4 Demonstrate use of computer communication systems | | | | | | | | | |
| H Use CNC Verification Programs | H-1 Identify CNC verification software programs | H-2 Program CNC verification using pull-down menus | | | | | | | | | | | |
| I Use CAD/CAM Programs | I-1 Demonstrate understanding of CAD/CAM programs | I-2 Access CAD program options | I-3 Create designs with CAD section of CAD/CAM program | I-4 Demonstrate ability to use program functions | I-5 Process tool path data | | | | | | | | |

220

221

TELEDYNE RYAN AERONAUTICALS
Panel Members

John Vang
Sr. Team Leader

Bruce Martenis
Team Leader

# APPENDIX B - PILOT PROGRAM NARRATIVE

What follows is a narrative of the pilot program which was conducted for this particular occupational specialty.

## MAST PILOT PROGRAM NARRATIVE: ADVANCED CNC/CAM TECHNICIAN

### Development of the Pilot Program

The MAST project staff and Associate Professor John C. Bollinger at San Diego City College used the skills standards development process, and the industry survey results in particular, to determine the optimal set of skills, knowledge and experience required to enter manufacturing employment as a Computer Numerical Control/Computer-Aided Machining (CNC/CAM) technician. Professor John Bollinger revised the existing course outlines in the Advanced CNC/CAM Technician curriculum to address the MAST skill standards and industry findings. Using the standard format adopted by the MAST consortium, Professor Bollinger incorporated both the technical workplace competencies identified as critical by industry and the SCANS foundation skills and competencies mandated for new training curricula in a growing number of states. In addition, MAST faculty and staff developed detailed crosswalks matching course objectives against both the technical workplace and SCANS competencies; the course outlines and crosswalks are included elsewhere in this volume.

To test the assumptions underlying the skill standards and industry findings, a MAST pilot program was developed at San Diego City College. The pilot curriculum was structured as a one-year certificate program encompassing progressively challenging courses designed to build student skills in the use of advanced CAM applications to CNC machining operations.

### Recruitment And Selection Process

Student selection for the MAST pilot program in Advanced CNC/CAM at San Diego City College began in the spring semester of 1995 for fall semester 1995. MAST staff and faculty canvassed current and prospective students regarding their interest in taking part in the pilot program. The co-location of a Continuing Education program in conventional machining in the same building, facilitated recruitment of eligible students for the pilot program, as did meetings conducted by college staff and faculty at high schools throughout San Diego County. Other recruitment tools included marketing brochures developed specifically for the MAST project, and coordination with staff of the San Diego Community College District Tech-Prep program. Students were selected for the pilot group based primarily on whether they were likely to follow a relatively fixed program schedule for two semesters rather than enroll in only one or two classes to improve or enhance current job skills. A total of 20 students were enrolled in the pilot program; all were pre- and post-tested and evaluated at the conclusion of the program to determine achievement of specific competencies.

### Industry and Secondary School Participation

No formal apprenticeship program is tied to the CNC/CAM program, but a number of informal relationships with local companies provide a strong source of internship opportunities. Many of the area's small- and medium-sized manufacturers have hired graduates and often refer potential students to the program for training. The meetings with area companies to develop the MAST skill standards further strengthened the program's ties with industry as well. As noted above, the MAST instructors held meetings with high school instructors throughout the San Diego County

secondary school system, and the College updated its articulation agreements with area high schools as a result of the MAST project.

**Final Evaluation of the Pilot Program**

Tabulating aggregate statistics for the pilot program was complicated by the mixture of MAST and non-MAST students in the pilot classes. In general, the 20 MAST students were roughly representative of the overall class profile.

-- More than 85% of all pilot students were **economically disadvantaged** (gross annual family income of $22,800 or less), and 70% of these were also members of ethnic **minority** groups. The pilot students were representative of City College as a whole, an inner-city minority institution with a very high percentage of economically disadvantaged students. The completion rate for this group was approximately 86%.

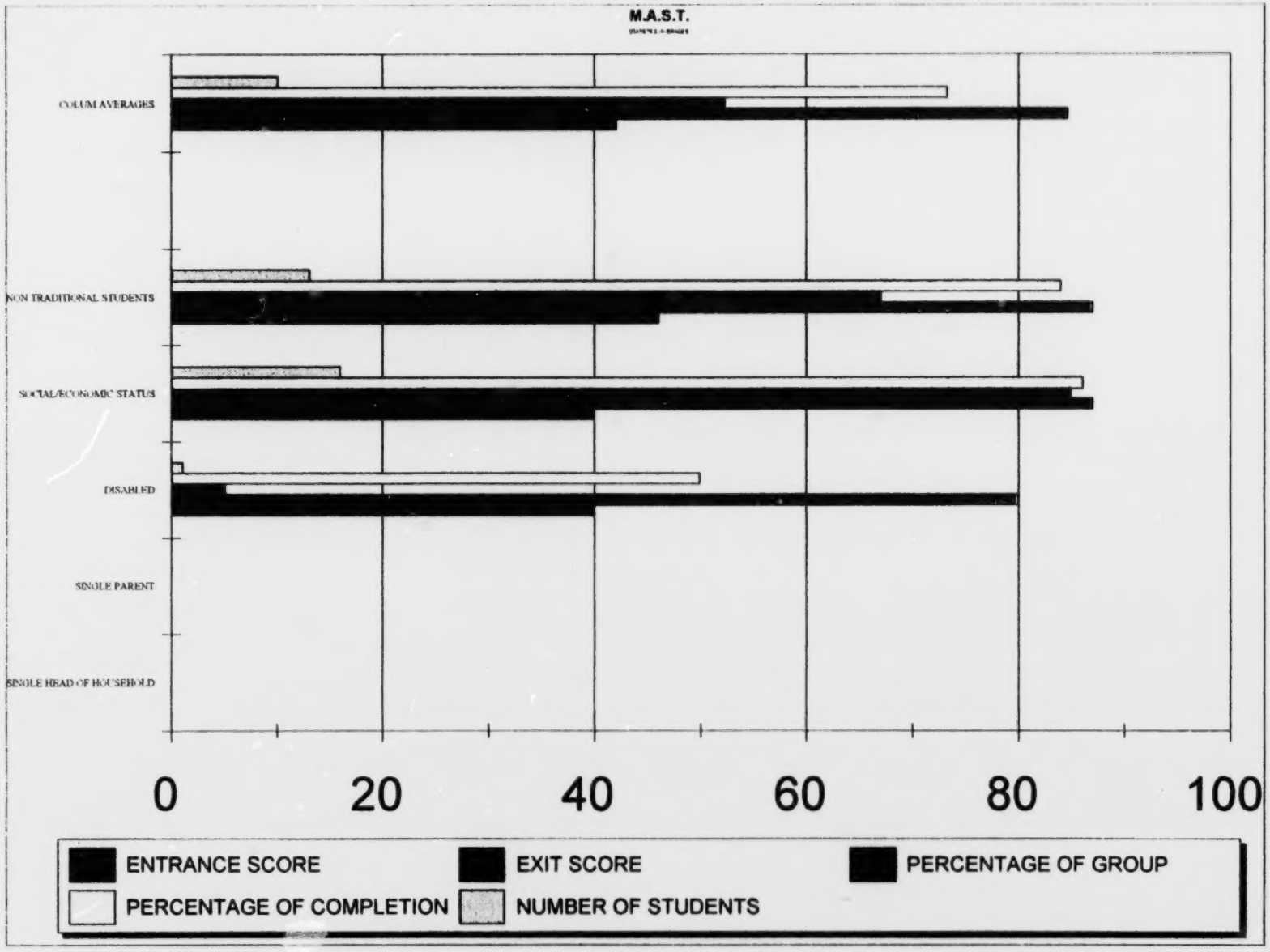
-- There were no single **parents** or **single heads of household** among the members of the MAST pilot group.

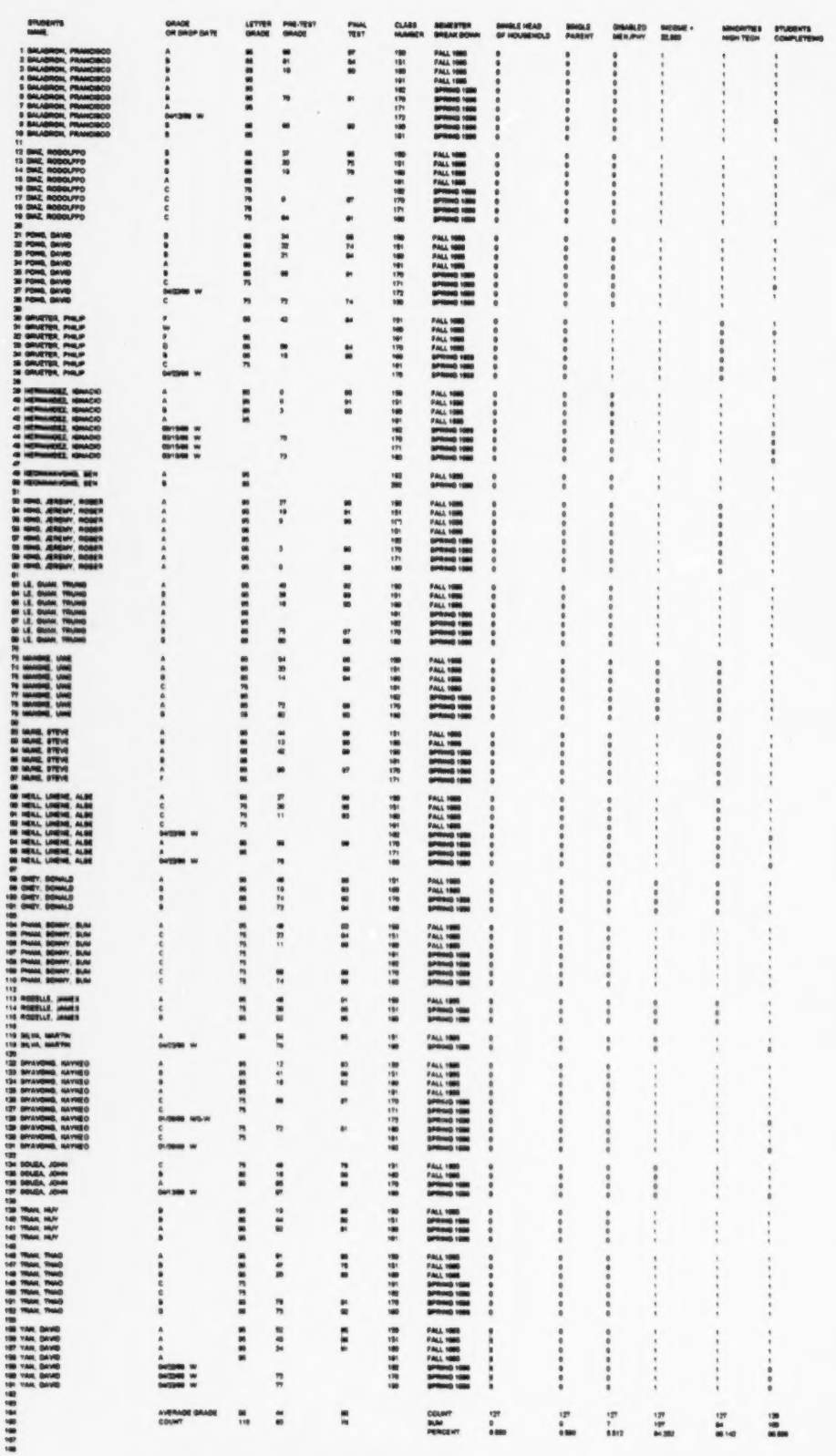
-- One student manifested severe retention problems as the program progressed but he elected to continue despite his **disability**; he eventually repeated three of the first four classes, finishing the year while dropping several classes. The student is expected to return next semester to continue his education. His entrance examination score was 40%, exit score 87%.

-- Students considered to be pursuing a **non-traditional occupation** comprised 67% of the pilot group (13/20); and 93% were economically disadvantaged. They completed 84% of all classes with an average entrance examination score of 46% and an average exit score of 87%.

**Conclusions**

A massive undertaking for all involved, the MAST project has yielded a great deal of valuable information regarding the needs and capabilities of students and the requirements and expectations of industry. When the MAST project was first suggested to College faculty, the machining program was in a state of flux, experimenting with different ways to accommodate the rapid changes occurring in technology and industry. The process of developing the skill standards helped to bring focus to the program, ensuring that all classes would meet industry requirements and have well-defined goals and outcomes. The process of industrial validation of the skill standards created opportunities to inform companies of the supply of trained workers available through the program. The relationships formed with federal labs and other manufacturing facilities provided valuable information regarding the applicability of the program technologies to unusual situations and non-traditional job opportunities. Largely as a result of the MAST pilot, the College began to explore ways to schedule classes more efficiently, while instructors raised their expectations regarding the ability of students to assimilate complex technologies and modified their courses accordingly. Another outcome of the studies done during the MAST program was that the college would eliminate its conventional machining program allowing the Continuing Education facility to teach all the conventional classes. This decision allowed the college to use it educational budget in teaching the advanced classes while still providing a location for the basics to be taught. This decision also ended the near duplication of the beginning classes.


M.A.S.T.
COLUM AVERAGES
NON TRADITIONAL STUDENTS
SOCIAL/ECONOMIC STATUS
DISABLED
SINGLE PARENT
SINGLE HEAD OF HOUSEHOLD
0
20
40
60
80
100
ENTRANCE SCORE
EXIT SCORE
PERCENTAGE OF GROUP
PERCENTAGE OF COMPLETION
NUMBER OF STUDENTS



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San Diego City College
1313 Twelfth Ave.
San Diego, Ca. 92101

## Machine Technology 150 Final Examination

### NO BOOKS OR NOTES

### DO NOT WRITE ON THIS TEST. WRITE ONLY ON THE SCANTRON SHEET.

This test is being given to see what you know. Do not look at anyone else's paper or ask anyone questions. If you have any questions ask the instructor. Raise your hand to get his attention.

If the instructor sees anyone looking at someone else's paper, or talking during the test, he/she will have their paper taken and receive a "0" grade for the test.

The pretest grade has no impact on your final grade, it simply allows us to measure information learned by the student.

**The answer "E" is always available as the answer NONE OF THE ABOVE**

1. The definition " a system in which actions are controlled by the insertion of numerical data at some point" refers to?
   a. Direct Numerical Control
   b. Distributive Numerical Control
   c. Numerical Control
   d. Computerized Numerical Control

2. Which company is given credit for creating the first numerical control milling machine?
   a. Rohr Industries
   b. Massachusetts Institute of Technology
   c. Parsons corporations
   d. General Electric

3. The term C.N.C. stands for?
   a. Continuous Numerical Control
   b. Centerline Numerical Control
   c. Computerized Numerical Control
   d. Computerized Numerical Counter

4. The term D.N.C. has multiple definitions one is:
   a. Distinct numerical control
   b. Desired numerical control
   c. Direct numerical control
   d. Destination numerical control

5. The term D.N.C. has multiple definitions another one is:
   a. District numerical control
   b. Distributive numerical control
   c. Distinctive numerical control
   d. Desired numerical control

6. Examples of basic elements of a C.N.C. system would include;
   a. Center drill
   b. Milling cutters
   c. Mouse
   d. Part program

7. Examples of basic elements of a C.N.C. system would include;
   a. Anilam
   b. Program input device
   c. Pocket calculator
   d. Coolant

8. Examples of basic elements of a C.N.C. system would include;
   a. Machine control unit
   b. Outside micrometer
   c. Pencil and paper
   d. Basic understanding of mathematics

9. Examples of basic elements of a C.N.C. system would include;
   a. Barcoding system
   b. Inside micrometer
   c. Drive systems
   d. Basic understanding of engineering drawings

10. Examples of basic elements of a C.N.C. system would include;
    a. Machine Tool
    b. Basic theory of metal removal
    c. Dial calipers
    d. Windows operating system

11. Examples of basic elements of a C.N.C. system would include;
    a. Clamping devices
    b. Depth micrometers
    c. Feedback systems
    d. Fine surface finishes

12. N. C. Systems are often referred to as :
    a. Primary memory
    b. Softwired
    c. Hardwired
    d. Secondary memory

13. C.N.C. Systems are often referred to as :
    a. Primary memory
    b. Softwired
    c. Hardwired
    d. Secondary memory

14. Examples of Advantages of C.N.C. would include:
    a. High cost of cutting tools
    b. Increased productivity
    c. Highly attractive machines
    d. More interesting for maintenance workers

15. Examples of Advantages of C.N.C. would include:
    a. Lower number of pallets needed
    b. Increased electronics
    c. Inch and metric calibrations
    d. High accuracy and repeatability

16. Examples of Advantages of C.N.C. would include:
    a. Reduced production costs
    b. Systems require less attention
    c. Cost effective for small production runs
    d. Lower maintenance requirements

17. Examples of Advantages of C.N.C. would include:
    a. Reduced initial investment
    b. Reduced indirect operating costs
    c. Cost effective for small production runs
    d. Lower maintenance requirements

18. C.N.C. Operators have to have a higher skill level then a precision tool maker
    a. True
    b. False

19. Examples of Dis- advantages (limitations) of C.N.C. would include:
    a. High cost of cutting tools
    b. Higher productivity
    c. High initial investment
    d. High probability of human error

20. Examples of Dis- advantages (limitations) of C.N.C. would include:
    a. Higher scrap rates
    b. Higher Maintenance requirements
    c. Higher machine utilization
    d. High probability of human error

21. Examples of Dis- advantages (limitations) of C.N.C. would include:
    a. Not cost effective for precision parts
    b. Not cost effective for alloys
    c. Not cost effective for low production levels
    d. Not cost effective for non ferrous metals

22. C.N.C. can only be applied to applications of chip removal:
    a. True
    b. False

23. The addition of C.N.C. Machines guarantees increased productivity
    a. True
    b. False

24. C.N.C. programming has been dramatically changed by the advent of:
    a. Fiber optics
    b. CAD/CAM
    c. Space age coolants
    d. Special applications

25. The Point to Point control system is most often used in _____ operations.
    a. Rough machining
    b. Pocket machining
    c. Drilling
    d. Contouring

26. The Continuous- Path control system is often called _____ System.
a. Rough machining b. Pocket machining c. Drilling d. Contouring

27. The Continuous- Path control system is limited since it can only move one axis at a time.
A. True b. False

28. An example of a function of the C.N.C. Interpolator would include;
a. Generates spindle speed calculations for efficient material removal
b. Generates intermediate coordinate positions along the program path
c. Generates the proper feed rate in program
d. Generates a complete list of "G" codes as needed by the machine

29. An example of a function of the C.N.C. Interpolator would include;
a. Computes coolant selections for machine tool as needed
b. Computes separate tool changes as needed
c. Computes individual axis velocities as needed
d. Computes material finish requirements as needed

30. One example of a common Interpolation would be.
a. Metabolic b. Bi cubic approximation c. Linear d. Helical cubic NURB

31. One example of a common Interpolation would be.
a. Eliptoidinal b. Bi nurdic eliptoidinal c. Radius d. Circular

32. One significant feature of the _____ control system is that there is no feedback signal for checking whether the programmed position has been reached.
a. Closed loop b. Open loop c. N.C. d. C.N.C.

33. One significant feature of the _____ control system is that there are feedback signals that check whether the programmed position has been reached.
a. Closed loop b. Open loop c. N.C. d. C.N.C.

34. The _____ control system is usually used with the Point to Point systems.
a. Closed loop b. Open loop c. N.C. d. C.N.C.

35. The _____ control system is usually used with Continuous Path systems.
a. Closed loop b. Open loop c. N.C. d. C.N.C.

36. The acronym M.C.U. Stands for:
a. Machine Companies Unification b. Machine control unit c. Machine control university
d. Machine control union

37. Examples of Primary memory would include:
a. Floppy disks b. Hard drives c. R.A.M. d. Paper tape

38. Examples of Primary memory would include:
a. Greco system b. D.N.C. c. R.O.M. d. Punch cards

39. Examples of Secondary memory would include:
a. Greco system b. D.N.C. c. R.O.M. d. Hard drives

40. Examples of Secondary memory would include:
a. Floppy disks b. Greco system c. R.A.M. d. Paper tape

41. Machine_____ is what allows us to reach a exact desired point coordinate.
a. Controller b. Repeatability c. Accuracy d. Programming

42. Machine_____ is what allows us to come back to an exact point coordinate time after time.
a. Controller b. Repeatability c. Accuracy d. Programming

43. The _____ Measurement feedback system are free from the effects of machine backlash.
a. Indirect b. Direct c. Closed loop d. Open loop

44. The _____ Measurement feedback system is effected by machine backlash.
a. Indirect b. Direct c. Closed loop d. Open loop

45. The _____ Measurement feedback system is more accurate.
a. Indirect b. Direct c. Closed loop d. Open loop

46. The machine axis designation by X,Y, and Z are the_____ Machine axis.
a. Tertiary linear b. Primary linear c. Secondary linear d. Primary rotary

47. The machine axis designation by A,B and C are the_____ Machine axis.
a. Tertiary rotary b. Primary rotary c. Secondary rotary d. Primary linear

48. The Cartesian Coordinate system is often referred to as the_____ coordinate system.
a. Polar b. Secondary c. Rectangular d. Primary

49. The data point X-1.0 Y-2.0 is located in the number _____Quadrant
a. 1 b. 2 c. 3 d. 4

50. The data point X 1.0 Y 2.0 is located in the number _____Quadrant
a. 1 b. 2 c. 3 d. 4

51. The data point X 1.0 Y- 2.0 is located in the number _____Quadrant
a. 1 b. 2 c. 3 d. 4

52. The data point X- 1.0 Y 2.0 is located in the number _____Quadrant
a. 1 b. 2 c. 3 d. 4

53. The _____coordinate system defines the position of a point by its radius and an angle of rotation.
a. Polar b. Secondary c. Rectangular d. Primary

54. If a data point was rotated 100 degrees from 0 it would be in the number_____ Quadrant.
a. 1 b. 2 c. 3 d. 4

55. If a data point was rotated 295 degrees from 0 it would be in the number_____ Quadrant.
a. 1 b. 2 c. 3 d. 4

56. If a data point was rotated 40 degrees from 0 it would be in the number_____ Quadrant.
a. 1 b. 2 c. 3 d. 4

57. If a data point was rotated 195 degrees from 0 it would be in the number_____ Quadrant.
a. 1 b. 2 c. 3 d. 4

58. In the _____Positioning system all positions are measured from a single fixed point.
a. Incremental b. Polar c. Rectangular d. Absolute

59. In the _____Positioning system, the reference point is not fixed and moves from data point to data point
a. Incremental b. Polar c. Rectangular d. Absolute

60. The command "G01" is an example of an N.C. _____
a. Address b. Word c. Block d. Program

61. In the command "G01" the G is an example of an N.C. _____
a. Address b. Word c. Block d. Program

62. "N01 G90 G80 G17" would be an example of an N.C._____
a. Address b. Word c. Block d. Program

63. A complete set of codes that would make a part would be called a_____.
a. Address b. Word c. Block d. Program

C.N.C. PROGRAMMING
Commonly used "G" & "M" CODES & MISCELLANEOUS CODES

64. G91:
a. HEIGHT (TOOL LENGTH OFFSET)
b. X,Y PLANE SELECTION
c. SET X,Y,Z, VALUES, RESET VALUES
d. INCREMENTAL PROGRAMMING
e. DRILL WITH DWELL AT END OF "Z" TRAVEL

65. G81:
a. FAST RAPID POSITIONING MOVE
b. OPTIONAL STOP, ACTS AS M00 OR DISAPPEARS
c. COMMON DRILL CYCLE
d. REAMING CYCLE, STOPS SPINDLE AT "Z" DEPTH
e. DRILL WITH DWELL AT END OF "Z" TRAVEL

66. G71:
a. INCREMENTAL PROGRAMMING
b. METRIC PROGRAMMING
c. SET X,Y,Z, VALUES, RESET VALUES
d. REAMING CYCLE, STOPS SPINDLE AT "Z" DEPTH
e. DRILL WITH DWELL AT END OF "Z" TRAVEL

67. M06:
a. SPINDLE ON CLOCKWISE
b. SPINDLE ON COUNTER CLOCK
c. MACHINE STOP, STOPS EVERYTHING
d. RETRACT SPINDLE TO HOME POSITION
e. KILLS CANNED CYCLES

68. G02:
a. COUNTER CLOCKWISE ARC REQUIRES AXIS MODIFIERS
b. STRAIGHT LINE MOVE REQUIRES FEED RATE
c. SET X,Y,Z, VALUES, RESET VALUES
d. CUTTER COMPENSATION LEFT
e. CLOCKWISE ARC REQUIRES AXIS MODIFIERS

69. "S":
a. FAST RAPID POSITIONING MOVE
b. STRAIGHT LINE MOVE REQUIRES FEED RATE
c. X AXIS MODIFIER
d. SPINDLE STOP
e. SPEED

70. M00:
a. KILL COOLANT
b. SET X,Y,Z, VALUES, RESET VALUES
c. OPTIONAL STOP, ACTS AS M00 OR DISAPPEARS
d. MACHINE STOP, STOPS EVERYTHING
e. SPINDLE STOP

71. G04:
    a. X,Y,AXIS MOVEMENT
    b. DWELL
    c. SET X,Y,Z, VALUES, RESET VALUES
    d. SPINDLE STOP
    e. COMMONLY STANDS FOR TOOL

72. G19:
    a. X,Y,AXIS MOVEMENT
    b. X,Y PLANE SELECTION
    c. X,Z PLANE SELECTION
    d. X,Z AXIS MOVEMENT
    e. Y,Z PLANE SELECTION

73. G00:
    a. FAST RAPID POSITIONING MOVE
    b. BORE IN AND OUT
    c. MACHINE STOP, STOPS EVERYTHING
    d. CUTTER COMPENSATION LEFT
    e. CANCELS CUTTER COMPENSATION

74. "I":
    a. INCREMENTAL PROGRAMMING
    b. Z AXIS MODIFIER
    c. X AXIS MODIFIER
    d. MIST COOLANT
    e. Y,Z PLANE SELECTION

75. G40:
    a. COUNTER CLOCKWISE ARC REQUIRES AXIS MODIFIERS
    b. SPINDLE ON COUNTER CLOCK
    c. KILL COOLANT
    d. KILLS CUTTER COMPENSATION
    e. KILLS CANNED CYCLES

76. M01:
    a. INCREMENTAL PROGRAMMING
    b. OPTIONAL STOP, ACTS AS M00 OR DISAPPEARS
    c. END OF PROGRAM, STOP
    d. MIST COOLANT
    e. CUTTER COMPENSATION RIGHT

77. M08:
    a. SPINDLE ON CLOCKWISE
    d. MIST COOLANT
    c. PECK CYCLE, DEEP HOLE DRILLING
    d. FLOOD COOLANT
    e. CLOCKWISE ARC REQUIRES AXIS MODIFIERS

78. G03:
    a. STRAIGHT LINE MOVE REQUIRES FEED RATE
    b. COMMON DRILL CYCLE
    c. CLOCKWISE ARC REQUIRES AXIS MODIFIERS
    d. CUTTER COMPENSATION RIGHT
    e. COUNTER CLOCKWISE ARC REQUIRES AXIS MODIFIERS

79. G41:
a. HEIGHT (TOOL LENGTH OFFSET)
b. Z AXIS MODIFIER
c. END OF PROGRAM, STOP
d. CUTTER COMPENSATION LEFT
e. CUTTER COMPENSATION RIGHT

80. M04:
a. SPINDLE ON CLOCKWISE
b. DWELL
c. MACHINE STOP, STOPS EVERYTHING
d. SPINDLE ON COUNTER CLOCKWISE
e. SPINDLE STOP

81. G42:
a. COUNTER CLOCKWISE ARC REQUIRES AXIS MODIFIERS
b. OPTIONAL STOP, ACTS AS M00 OR DISAPPEARS
c. PECK CYCLE, DEEP HOLE DRILLING
d. CUTTER COMPENSATION LEFT
e. CUTTER COMPENSATION RIGHT

82. M09:
a. COUNTER CLOCKWISE ARC REQUIRES AXIS MODIFIERS
b. SPINDLE ON COUNTER CLOCK
c. KILL COOLANT
d. KILLS CUTTER COMPENSATION
e. KILLS CANNED CYCLES

83. G70:
a. INCREMENTAL PROGRAMMING
b. METRIC PROGRAMMING
c. SET X,Y,Z, VALUES, RESET VALUES
d. INCH PROGRAMMING
e. DRILL WITH DWELL AT END OF "Z" TRAVEL

84. "F":
a. FAST RAPID POSITIONING MOVE
b. FEED
c. COMMON DRILL CYCLE
d. FLOOD COOLANT
e. OFFSET NUMBER (TOOL DIAMETER)

85. M02:
a. SPINDLE ON CLOCKWISE
b. SPINDLE ON COUNTER CLOCKWISE
c. END OF PROGRAM, STOP
d. END OF PROGRAM, RETURN TO BEGINNING OF PROGRAM AND WAIT
e. CUTTER COMPENSATION RIGHT

86. G80:
a. COUNTER CLOCKWISE ARC REQUIRES AXIS MODIFIERS
b. SPINDLE ON COUNTER CLOCK
c. KILL COOLANT
d. KILLS CUTTER COMPENSATION
e. KILLS CANNED CYCLES

87. G82:
a. COMMON MILL CYCLE
b. BORE IN AND OUT
c. PECK CYCLE, DEEP HOLE DRILLING
d. REAMING CYCLE, STOPS SPINDLE AT "Z" DEPTH
e. DRILL WITH DWELL AT END OF "Z" TRAVEL

88. G01:
a. FAST RAPID POSITIONING MOVE
b. STRAIGHT LINE MOVE REQUIRES FEED RATE
c. SET X,Y,Z, VALUES, RESET VALUES
d. REAMING CYCLE, STOPS SPINDLE AT "Z" DEPTH
e. X,Z AXIS MOVEMENT

89. G83:
a. COMMON DRILL CYCLE
b. REAMING CYCLE, STOPS SPINDLE AT "Z" DEPTH
c. PECK CYCLE, DEEP HOLE DRILLING
d. REAMING CYCLE, STOPS SPINDLE AT "Z" DEPTH
e. DRILL WITH DWELL AT END OF "Z" TRAVEL

90. G17:
a. X,Y,AXIS MOVEMENT
b. X,Y PLANE SELECTION
c. X,Z PLANE SELECTION
d. X,Z AXIS MOVEMENT
e. Y,Z PLANE SELECTION

91. "J":
a. HEIGHT (TOOL LENGTH OFFSET)
b. Z AXIS MODIFIER
c. Y AXIS MODIFIER
d. Z AXIS MODIFIER
e. Y,Z PLANE SELECTION

92. M03:
a. SPINDLE ON CLOCKWISE
b. DWELL
c. END OF PROGRAM, STOP
d. SPINDLE STOP
e. CLOCKWISE ARC REQUIRES AXIS MODIFIERS

93. G90:
a. INCREMENTAL PROGRAMMING
b. METRIC PROGRAMMING
c. X,Z, PLANE SELECTION
d. ABSOLUTE PROGRAMMING
e. CANCELS CUTTER COMPENSATION

94. M05:
a. SPINDLE ON CLOCKWISE
b. DWELL
c. MACHINE STOP, STOPS EVERYTHING
d. SPINDLE STOP
e. CANCELS CUTTER COMPENSATION

95. M07:
a. SPINDLE ON CLOCKWISE
b. MIST COOLANT
c. PECK CYCLE, DEEP HOLE DRILLING
d. FLOOD COOLANT
e. CLOCKWISE ARC REQUIRES AXIS MODIFIERS

96. M30:
a. SPINDLE ON CLOCKWISE
b. SPINDLE ON COUNTER CLOCKWISE
c. END OF PROGRAM, STOP
d. END OF PROGRAM, RETURN TO BEGINNING OF PROGRAM AND WAIT
e. CUTTER COMPENSATION RIGHT

97. "T":
a. HEIGHT (TOOL LENGTH OFFSET)
b. FEED
c. END OF PROGRAM, STOP
d. MIST COOLANT
e. COMMONLY STANDS FOR TOOL

98. G18:
a. X,Z,PLANE MOVEMENT
b. X,Z PLANE SELECTION
c. Y,Z PLANE SELECTION
d. Y,Z AXIS MOVEMENT
e. X,Z AXIS MOVEMENT

99. "K":
a. x AXIS MODIFIER
b. Z AXIS MODIFIER
c. Y AXIS MODIFIER
d. X,Z, PLANE SELECTION
e. y,Z, PLANE SELECTION

100. What do you think your grade should be for this class this semester?
a. A b. B c. C d. D e. F

When you are done with this test give it and your answer sheet to the instructor.

San Diego City College
1313 Twelfth Ave.
San Diego, Ca. 92101

**Machine Technology 151 Final Examination**

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1. What machining processes can we verify in Vericut?

   a. Mill only
   b. Lathe only
   c. Surface grinding
   d. Mill and lathe

Before you start the VERICUT program you need to have a #2 file. We also need know the #3 dimension and the difference between the #4, and the #5.

2. a. *.nc
   b. *.nci
   c. *.tp
   d. *.txt

3. a. stock
   b. tools
   c. all depths
   d. offsets

4. a. part X,Y,Z location
   b. tools
   c. true zero
   d. cutter height

5. a. arc tolerances
   b. offsets
   c. Translated X,Y,Z location
   d. true height

What extension of the file is actually used to run VERICUT? #6 ?
What type of file format is this file # 7 ?

6. a. *.nci
   b. *.nc
   c. *.txt
   d. *.tp

7. a. TXT
   b. APT
   c. NC
   d. NCI

What are two good reasons to run off of the hard drive for VERICUT ? # 8 , and # 9.

8. a. Vericut will only accept "C" drive.
   b. More available drive space
   c. Less available drive space
   d. None of these

9. a. better resolution
   b. VERICUT will run slower
   c. VERICUT will run faster
   d. none of these

Questions 10, 11, 12, 13, 14

During the initial conversion from Mastercam to the VERICUT verification process, we are asked five questions. In sequence, identify these questions.

10. a. enter input file name
    b. enter input file extension
    c. enter part name
    d. enter output file name

11. a. enter input file name
    b. enter part name
    c. enter output file name
    d. enter output file extension

12. a. enter flute length
    b. enter arc tolerance
    c. enter cutter height
    d. enter cutter "z" depth

13. a. enter .01
    b. enter circular interpolation tolerance
    c. enter circular arc direction
    d. enter circular arc offset

14. a. enter cutter "Z"depth
    b. enter final part tolerance
    c. enter coordinate measurements in degrees
    d. Enter tool change height

15. From C:\BAT> what command can we use to convert a file for verification in VERICUT?
    a. mchv2
    b. v2mcam
    c. mcam2v
    d mcam2v21

16. To start VERICUT from the C:\Bat> prompt, we type ?
    a. VERICUT
    b. ver21
    c. v21
    d. mcam2v

17. Why don't we have to define each of our tools separately in VERICUT ?
    a. tools are listed in the NC file
    b. VERICUT has its own tool library
    c. tools are listed in the NCI file
    d. tools are listed in the Mastercam pocket parameters

In the icon windows, the STOCK is used to define the # 18 of our material, The #19 , and of our material and the # 20 distances or values.

18 a. size
   b. height
   c. shape
   d. values

19. a . X,Y,and Z
    b. plane, rotation, and axis
    c. position, depth, and size
    d. dimension, tolerance, and arcs

20. a. Rotational
    b. positional
    c. transversal
    d. translated

Match the following functions with the Icon window.

| | |
|---|---|
| 21. shade | a. Color |
| 22. Resolution | b. View |
| 23. Scale | c. Setup cut |

Match the following functions to the Icon window.

| | |
|---|---|
| 24. Leave VERICUT | a. User file |
| 25. Fast feed | b. Exit |
| 26. Save file | c. Snapshot Files |
| 27. Save image | d. Setup cut |

28. What happens to our process when we create our model at a larger scale ?
    a. Speeds up the verification process
    b. Slows down the verification process
    c. Has no effect on the verification process
    d. Provides poor resolution in the verification process

If we have programmed feedrates over 50 ipm we must increase the #29 , This is listed under the # 30 window.

29. a. spindle speed
b. chip load per tooth
c. CS
d. fast feed

30. a. Stock
b. View
c. Color
d. Setup cut

31. If we would like to take pictures during the verification process we would choose the # 31 icon window?
a. utilities
b. view
c. shdcopy
d. snapshot file

If we would like to take pictures of the verification process automatically and as one file we would choose #32 ,the file extension inserted by the operator would be #33 ?,after the process is completed the extension would be # 34 .

32 a. save,as
b. auto on,autoappend
c. save
d. none of these

33. a. ss
b. as
c. ae
d. none of these

34. a. as
b ss
c ae
d none of these

If we wanted to take pictures when there was a possible crash we would set the selection #35 , the extension would be # 36 ?

35. a auto crash
b picture
c snapshot
d auto error

36. a pic
b ae
c ss
d none of these

Within the various icon windows we see D> and F> the D>indicates #37 and the F> indicates #38 ?

37. a drive
b directory
c path
d filename

38. a filename without extension
b filename with extension
c Extension only
d *.tp extension

After we have entered all the data under all of the icon windows it would be wise to save the information so we would not have to enter it the next time we wanted to verify this part. To do this we would choose the # 39 icon window? This file would have the extension # 40 ?

39. a verify files
b user files
c IP files
d view

40. a *.ver
b *.ss
c *.usr
d *.sav

41. Before we can start the machining process in VERICUT we have to paint the model on the computer screen .What icon do we choose perform this function.

a. paint model
b. display model
c. view model
d. show model

42. What icon do we choose to start the machining process in the graphics window?

a. display model
b. cut model
c. view
d. setup cut

43. To interrupt the machining process,you would use the following keys on the keyboard?

a. hold down control and press "c"
b. Press control, alt, and delete at the same time
c. press alt,"c"
d. press enter

44. If we use faster feeds in our program what will the effect be in VERICUT?

a. program will run faster
b. program will run slower
c. better surface finish
d. none

To turn the cutter display off you would choose the # 45 icon window, this will cause VERICUT to #46 ?

5. a. Run faster
b. view
c. shdcopy
d. setup cut

46. a. run slower
b. run faster
c. have better resolution
d. stay the same

What is the operation used in Mastercam to verify toolpaths # 47 ? This is a limited process since it only shows the # 48 .

47 a. plot
b. backplot
c. Edit nci
d. nc util

48. a. wire frame
b. cutter compensation
c. toolpath centerline
d. view

## Dos Commands

To copy a file named Test.151 from a:> to c:\zip> you would type # 49 from the a:\> prompt?

49 a. Copy test.151 c:\zip
b. Copytest.151c:\zip
c. Test.151 copy c:\zip
d. Any of the above

To change from A: drive to C: drive you would type the command # 50 ?

50 a. Change c:
b. C:
c. C:\>
d. Cd \c:

To erase all the files ending with a "151" extension you would type # 51 ?

51 a. erase *.*151
b. del *.*151
c. del *.151
d. rem *.151

To make a sub-directory named "verify" on drive A:/>you would type # 52? from the a:\> prompt ?

52 a. Verify
b. SD Verify
c. MD Verify
d. Sub Verify

If the directory a:\verify> was empty, to remove it you would type # 53 from the A:\>prompt ?

53. a. Rem a:\verify
b. RemDir a:\verify
c. RD verify
d. Del verify

54. A file name is limited to #54 characters under Dos?
a. 10 b. 11 c. 8 d. none of these

55. An extension is limited to #55 characters under Dos?
a. 5 b. 3 c. 8 d. none of these

56. What does a switch look like?
a. \ b.: c. / d. >

57. What does a backslash look like?
a. \ b : c. / d. >

58. If you wanted to view all the files on drive A: without using any switches from the A:\>prompt you would type # 58 ?
a. View b. ren c. Dir d. Type

59. What would you type at the c:\> prompt to format a floppy in drive "A"?
a. Format b. A:/ format c. Format a: d. C:\Bat\Format\A:

60. What would you type at the C:BAT> prompt if you wanted to format a floppy in drive A, and make it a system disk.
a. format a: \sys b. format a: sys c. format a: /s d. format a: /p

61. To change from the C:\bat> dir to the C:\Zip> dir what command would you type?
a. Goto\Zip b. CD Zip c. Md\Zip d. CD\Zip

## Windows Commands

To view a list of all programs that are running (task list) you would hold down the #62 key and push the #63 key.

62. a. alt
    b. tab
    c. cntrl
    d. esc

63. a. tab
    b. esc
    c. shift
    d. alt

To cycle through the list of active tasks you would hold down the #64 key and press the #65 key.

64. a. tab
    b. shift
    c. alt
    d. cntrl

65. a. tab
    b. shift
    c. cntrl
    d. alt

To close the current program you would hold down the #66 key and press the #67 key.

66. a. ctrl
    b. alt
    c. shift
    d. esc

67. a. Fl
    b. F4
    c. Print scrn
    d. esc

To close the current document window you would hold down the #68 key and press the #69 key.

68. a alt
    b. cntrl
    c. shift
    d. F4

69. a. esc
    b. tab
    c. F4
    d. cntrl

To use the pulldown menus at the top of the window you would hold down the #70 key and press the #71 key.

70. a. alt
    b. tab
    c. shift
    d. cntrl

71. a. first letter
    b. underlined letter
    c. capital letter
    d. any letter

To exit an active windows application you can #72 .

72. a. use the file menu
    b. use the mouse double click method
    c. use the alt + F4 keys
    d. all of the above.

73. In addition to Vericut, what other software do we use that only does toolpath verification?

    a. FADAL
    b. Mastercam
    c. N-SEE-see
    d. Surfcam

74. The main difference between the verification software from question 73 and Vericut is?

a. It uses the *.nci file to verify the toolpath
b. It uses the *.ge3 file to verify the toolpath
c. It uses the *.nc file to verify the toolpath
d. It uses the *.tp file to verify the toolpath

75. Why do we have to define each of the required tools separately in the verification software from question #73.

a. Tools are not defined in the setup cut icon window
b. Tools are not defined in the *.nci file.
c. Tools are not defined in the *.nc file
d. Tools are not required in this verification process.

76. What machining process(s) can we verify in this verification software?
a. mill only
b. lathe only
c. surface grinding
d. mill and lathe only

Before you start the N-SEE *process* you need to have an #77 file. We also need to know the #78 dimension, the location of the #79 , the #80 and also the #81, and the #82 .

77. a. *.NC
b. *.NCI
c. *.TXT
d. *.TP

78. a. stock
b. color
c. offset
d. all Z depth

. a. part X,Y,Z zero ?
b. tools
c. true zero
d. cutter height

80. a. arc tolerances
b. offsets
c. translated X,Y,Z location
d. true height

81. a. feed rates
b. tools descriptions
c. true zero
d. rpm

82. a. program number
b. machine controller type
c. data collection mode
d. machine bar code number

83. In what module in N-SEE would we see the tools as they cut the part.
a. Turbo
b. verify
c. windows
d. preview

84. In what module in N-SEE would we use if we wanted to cross section the part for inspection purposes.
    a. turbo
    b. preview
    c. windows
    d. verify

85. What menu selection would we use to set the proper machine controller in N-SEE.
    a. set up cut, sel control
    b. utility, sel control
    c. options, sel controller
    d. start , machine control

86. What is the file extension for the tool list used in N-SEE-see?
    a. *.as
    b. *.pic
    c. *.tp
    d. *.tlb

87. A faster Feedrate will make Vericut, and N-SEE-see run faster.
    a. True
    b. False

88. Both Vericut and N-SEE-see can save a company money, and time.
    a. True
    b. False

89. What did you think of this test?

    a. to easy  b. easy  c. O.K.  d. hard  e. terrible

90. What do you think your FINAL grade should be for this class this semester.

    a. A  b. B  c. C  d. D  e. F

**When you are done with this test give it to the Instructor, Have a nice break. See you soon.**

**San Diego City College**
1313 Twelfth Ave.
San Diego, Ca. 92101

**Machine Technology 160 Final Examination**

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The pretest grade has no impact on your final grade it simply allows us to measure information learned by the student.

1. To switch between open windows applications you would use the ____,____ Keys from this selection.
   a. Cntrl/Alt  b. Tab/Cntrl  c. Alt/Tab  d. Tab/esc

2. What Windows application takes the place of most D.O.S. commands?
   a. Write  b. Paint  c. File manager  d. Program Manager

3. Using Windows you can have *more* then one application open at a time?
   a. True  b. False

4. You can see "list" all the open applications you have in Windows using the____/____Keys from this selection.
   a. Cntrl/Alt/Del  b. Tab/Cntrl  c. Alt/Tab  d. Cntrl/Esc

5. To send a graphic image to the Clipboard so we can print it from the Paint program we would use the _____. Keys from this selection.
   a. Alt/Del  b. Cntrl/Print Screen  c. Alt/Tab  d. Cntrl/Alt

**READ THE FOLLOWING QUESTION CLOSELY!!!!!!**

7. To copy a file named: 2DEX1.TXT from A:\ to C:\ZIP> you would type__#7__from the A:\> prompt.

   a. COPY 2DEX1.TXT C:\ZIP
   b. COPY2DEX1.TXTC:\ZIP
   c. 2DEX1.TXT COPY C:\ZIP
   d. COPY *.*2DEX1.TXT C:\ZIP
   e. all of the above

8. To change from A:\> to C:\> drive you would type:
   a. C:/  b. C:A:  c. CD C:  d. C:

9. To erase all the files ending with the extension "TXT" you would type #9 at the A:\> prompt.
   a. ERASE *.*TXT
   b. REMOVE TXT.*
   c. DEL *.*TXT
   d. DEL *.TXT
   e. none of the above

10. To make a sub-directory named "ZIP" on drive A:\> you would type #10 at the A:\> prompt.
   a. ZIP  b. MD "ZIP  c. MD ZIP  d. none of these

11. If the directory B:\ZIP> was empty and you wanted to remove it you would type #11 at the B:\> prompt.
   a. DEL B:\ZIP  b. REN B:\ZIP  c. ERASE B:\ZIP  d. RD ZIP

12. A file name is limited to #12 characters? If required do not count the period.
   a. 7  b. 3  c. 8  d. 9  e. none of these

13. An extension name is limited to #13 characters? If required do not count the period.
   a. 7  b. 3  c. 8  d. 9  e. none of these

14. What does a switch look like?
   a. ?  b. /  c. \  d. >

15. What does a backslash look like?
   a. ?  b. /  c. \  d. >

16. If you wanted to view all the files in "A" drive without added any switches you would type #16 at the A:> prompt.
   a. VIEW  b. REN  c. ZIP  d. DIR

17. What would you type from the C:\ZIP> prompt to format a floppy disk in drive "A".
   a. A:\FORMAT
   b. FORMAT
   c. C:\ FORMAT\A:\
   d. FORMAT A:
   e. NONE OF THE ABOVE

## MASTERCAM

18. What are the reason(s) to use the hard drive for Mastercam?
   a. It is the only drive that Mastercam will recognize
   b. The floppy disks will only work when formatted by mastercam
   c. More available space and faster response time
   d. Slower response time and more available space

19. Mastercam is #19 ?
   a. a stand alone program use exclusively at City College
   b. a scientific graphics program
   c. a fully integrated CAD/CAM program
   d. none of the above

20. Mastercam creates #20 ?
    a. drawings
    b. geometry
    c. only single entity wire frame outlines
    d. mathematical equations only

21. The file extension for a mastercam graphics file is: #21 .
    a. .nc
    b. .nci
    c. .dfx
    d. .ge3
    e. .tp

22. The file extension for a mastercam CNC program is: #22 .
    a. .nc
    b. .nci
    c. .dxf
    d. .ge3
    e. .tp

Question 23, 24, 25, 26

As soon as we choose the **toolpath** menu we crossed over from the #23 section into the #24 section of mastercam. The extension for this file is #25 , this stands for #26

Answer selection to the above questions.

23. a. graphics
    b. ruled
    c. swept
    d. CAD
    e. CAM

24. a. toolpath
    b. swept
    c. graphics
    d. CAD
    e. CAM

25. a. .nci
    b. .nc
    c. .doc
    d. .ma
    e. .tp

26. a. numerical control intermediate
    b. numerical control
    c. document file
    d. mastercam file
    e. tool path

27. Name two data exchange formats we can use to retrieve other companies designs into mastercam.
    a. ges and ge3
    b. dex and ge3
    c. dxf and igs
    d. igs and ge3

28. Which mastercam menu is used to "DRAW" geometry?
    a. create  b. file  c. drafting  d. line  e. nc edit

29. Which mastercam menu selection is used to save or get geometry:
    a. save  b. next menu  c. nc utilities  d. file



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Question 30 and 31

If I was cutting along the outside of project 2dex1 this would be considered a #30 , which cutter compensation would I use to climb mill #31 ?

Answer selection to the above questions.

30. a. pocket
b. drill
c. swept
d. contour
e. ruled

31. a. cutter compensation off
b. cutter compensation left
c. cutter compensation right
d. deflect cutter compensation
e. cutter compensation center

Question 32 and 33

If I was cutting along the inside of project 2dex1 this would be considered a #32 , which cutter compensation would I use to climb mill #33 ?

Answer selection to the above questions.

32. a. pocket
b. drill
c. swept
d. contour
e. ruled

33. a. cutter compensation off
b. cutter compensation left
c. cutter compensation right
d. deflect cutter compensation
e. cutter compensation center

Question 34, 35,36

Name three ways of drawing a line in mastercam? (from the main menu)

Answer selection to the above questions.

34. a. create, line, polar
d. line, horizontal, values
b. create, line, segments
c. draw, line, horizontal

35. a. create, line, endpoints
b. create, endpoints, line
c. draw, line, sketch
d. create, line, position
e. create, line, larger

36. a. create ,line, horizontal
b. create, line, 2 pt cir
c. create, line, fillet
d. draw, line, vertical
e. line, draw, straight

Question 37, 38, 39

Name three ways of drawing an arc in mastercam? (from the main menu)

Answer selection to the above questions.

37. a. create, arc, radius
    b. create, arc, vertical
    c. create, arc, endpoints
    d. arc, horizontal, values

38. a. create, arc,, angle
    b. create, endpoints, arc
    c. draw, arc, sketch
    d. create, arc, perpendicular
    e. create, arc, polar

39. a. create, arc, multi
    b. create, arc, 3 points
    c. create, arc, fillet
    d. draw, arc, vertical
    e. arc, draw, curve

Question 40, 41,42
Name three ways of drawing an point in mastercam? (from the main menu)

Answer selection to the above questions.

40. a. create, point, endpoints, sketch
    b. create, point, position, values
    c. create, point, center, values
    d. create, point, intersection, midpoint

41. a. create, point, arc, midpoint
    b. create, point, line, point
    c. create, point, radius, midpoint
    d. create, point, position, endpoints

42. a. create, point, angle, midpoint
    b. create, point, perpendicular, sketch
    c. create, point, surface, sketch
    d. create, point, position, center

43. If I wanted to zoom a window in mastercam using the function keys I would use #43 .
    a. F1
    b. F7
    c. F5
    d. F10
    e. Alt F1

44. If I wanted to automatically fit a design in mastercam using the function keys I would use #44 .
    a. F1
    b. F7
    c. F5
    d. F10
    e. Alt F1

45. If I wanted to delete an entity in mastercam using the function keys I would use #45 .
    a. F1
    b. F7
    c. F5
    d. F10
    e. Alt F1

46. If I wanted to modify an entity in mastercam using the function keys I would use #46 .
    a. F1
    b. F7
    c. F5
    d. F10
    e. Alt F1

47. If I wanted to repaint the design in mastercam using the function keys I would use #47 .
    a. F1
    b. F2
    c. F3
    d. F4
    e. F5

48. If I wasn't sure of a function key in mastercam I would use the #48 function key.
    a. F1
    b. F3
    c. F5
    d. F10
    e. Alt F1

49. To make a print out of the design created in mastercam I would choose, #49 , , .
    a. File, exit, A:\print
    b. File, create, print
    c. Create, print, hard copy
    d. File, hard copy
    e. Create, print, design

Question 50,51, 52

What is the operation used in mastercam that is a form of verification #50 . This is a limited process since it only shows the #51 , of the toolpath. It also shows the #52 it estimated to machine the part.

Answer selection to the above questions.

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| J. | a. | NSEE | 51. | a. | toolpath | 52. | a. | space |
| | b. | Vericut | | b. | visual aid | | b. | cuts |

250

c. plot
d. backplot
e. edit nci

c. tool change
d. cutter number
e. cutter center lines

c. section area
d. fixture
e. time

53. If I wanted to add a new toolpath to an existing toolpath I would use the #53 choice, in the toolpath section.
    a. write over
    b. delete
    c. auto delete
    d. append
    e. all of the above

54. If I wanted to remove a section of toolpath from an existing file I would use_____/_____. (from the main menu)
    a. file, get
    b. file, delete
    c. nc utilities, plot
    d. nc utilities, geometry
    e. nc utilities, edit nci

55. If I wanted to change a "toolpath" into a CNC program I would have run the _____ application.
    a. backplot/plot
    b. convert to a .tp file
    c. post process
    d. edit nc
    e. none of the above

56. A rule of thumb for the depth of cut would be.
    a. full depth of cut of the flute length
    b. three quarter depth of cut of the cutter diameter
    c. one fourth to one half depth of cut of the cutter diameter
    d. not relative to the flute length or cutter diameter
    e. one eight depth of cut of the flute length

57. What factor if increased 50%, would have the #1 bad effect on the cutter life.
    a. depth of cut
    b. feed
    c. RPM
    d. surface feed per minute
    e. length of cutter flute

58. What factor if increased 50%, would have the #2 bad effect on the cutter life.
    a. RPM
    b. surface feed per minute
    c. depth of cut
    d. feed
    e. length of cutter flute

59. What factor if increased 50%, would have the least bad effect on the cutter life.
    a. RPM
    b. feed
    c. depth of cut
    d. surface feed per minute
    e. length of cutter flute

60. If I wanted to make some changes in the CNC program I would have to use the__#65__ selection.
    a. .ge3 file
    b. .tp file
    c. edit
    d. vericut program
    e. nsee program

61. To activate the editor in mastercam I would have to choose____/_____/_____. (from the main menu)
    a. directory, file, edit
    b. file, post process, edit
    c. create, nc utilities, change
    d. file, edit, nc
    e. none of the above

62. In the editor, if I decide not to keep the changes I made, I would select __/__.
    a. File, close
    b. File, New
    c. File, Stop
    d. File, Hope
    e. none of the above

63. In the editor, if I decide to keep the changes I made,with the same name, I would select __/__.
    a. File, Save as
    b. File, New
    c. File, Close
    d. File, Save

4. In the editor, if I wanted to keep the changes to the program I made, but give it a different name I would select ___/___.
    a. File, Save as
    b. File, New
    c. File, Close
    d. File, Save

65. In the editor, if I wanted to keep the changes to the program I made, but save it to a different location I would enter___/___
    a. F10, F9
    b. F9, F10
    c. F10, F4
    d. F10, F8
    e. F10, F7

66. What is the formula for calculating spindle speeds for CNC machining in Revolutions Per Minute?
    a. RPM= Pi X D divided by CS X 12
    b. RPM= CS X 12 divided by Pi X D
    c. RPM= CS X 4 divided by D
    d. none, automatically set with MDI on the CNC machine

67. What is the formula for calculating feeds for CNC machining in Inches Per Minute?

    a. IPM= Pi X D divided by CS X 12
    b. IPM= number of teeth on cutter X chip load per tooth
    c. none, geometry set with MDI on the CNC machine
    d. IPM= RPM X number of teeth on cutter X chip load per tooth

Calculate the following RPM's and feed rates. Use your calculator and set for 3 decimal places.

| | C.S | DIA. | RPM | IPM | = | CPT | # of TEETH |
|---|---|---|---|---|---|---|---|
| 68. | 250 | .125 | ____ | ____ | | .002 | 4 |
| 69. | 300 | 1.250 | ____ | ____ | | .0125 | 15 |
| 70. | 325 | .875 | ____ | ____ | | .003 | 2 |
| 71. | 25 | .500 | ____ | ____ | | .006 | 3 |
| 72. | 100 | .187 | ____ | ____ | | .001 | 6 |

Answer selection for the above questions.

68.
    RPM's IPM's
    a. 8000.000 / 64.000
    b. 7639.437 / 61.115
    c. 119.366 / 0.955
    d. none of the above

69.
    RPM'S IPM'S
    a. 916.732 / 171.887
    b. 1432.394 / 268.574
    c. 960.000 / 180.000
    d. none of the above

70.
    RPM's IPM's
    a. 1418.753 / 8.513
    b. 2.749 / 0.016
    c. 1485.714 / 8.914
    d. none of the above

71.
    RPM'S IPM'S
    a. 2000.000 / 3.600
    b. 190.986 / 3.438
    c. 1884.956 / 33.929
    d. none of the above

72.
    RPM's IPM's
    a. 20159.953 / 120.960
    b. 2139.037 / 12.834
    c. 2042.630 / 12.256
    d. none of the above

73. When we have an extremely long *.nci file, we may be able to make it smaller in size by?
    a. Skipping some of the operations
    b. Increasing the feed rate
    c. Filtering the *.nci file
    d. increasing the R.P.M. 's

74. We can change a *.nc file into a *.nci file, this process is called?
    a. Backplotting
    b. Sectioning
    c. Filtering
    d. Reverse post processing

75. The reason we use a CAD/CAM package to generate a C.N.C. program is because.
    a. It is more fun
    b. It looks much better
    c. It can be quicker
    d. parts can be more expensive

76. In MasterCam If I saw a file *2dex1.ge3* ,I would know that it is a.
    a. C.N.C. program
    b. Tool file
    c. Material document
    d. Geometry file
    e. set up sheet

77. In MasterCam If I saw a file *2dex1.igs* ,I would know that it is
    a. C.N.C. program b. Tool file c. Material document d. Conversion file
    e. set up sheet

78. In MasterCam If I saw a file *2dex1.nc*, I would know that it is
    a. C.N.C. program b. Tool file c. Material document d. Geometry file
    e. set up sheet

79. In MasterCam if I wanted to document the tools I am using for a project, I could have the computer check the *.nci file and create a ___. This could be given to the operator, or used later.
    a. C.N.C. program b. Tool file c. Material document d. Geometry file
    e. set up sheet

80. In MasterCam If I wanted to load a pre-existing *.ge3 I would use:
    a. File/Get b. File/edit c. File/convert d. Nc utils/Backplot
    e. Nc utils/Edit nci

81. In MasterCam If I wanted to run a pre-existing *.nci I would use:
    a. File/Get b. File/edit c. File/convert d. Nc utils/Backplot
    e. Nc utils/Edit ncim

82. In MasterCam If I wanted to change a pre-existing *.nci I would use:
    a. File/Get b. File/read c. File/convert d. Nc utils/Backplot
    e. Nc utils/Edit nci

83. In MasterCam If I wanted to change a pre-existing *.nc I would use:
    a. File/Get b. File/edit c. File/convert d. Nc utils/Backplot
    e. Nc utils/Edit nci

84. In MasterCam If I wanted to change a pre-existing *.ge3 so I could view it in Cadkey I would use:
    a. File/Get b. File/edit c. File/convert d. Nc utils/Backplot
    e. Nc utils/Edit nci

85. In MasterCam If I wanted to keep a *.ge3 I would use:
    a. File/Get b. File/save c. File/convert d. Nc utils/Backplot
    e. Nc utils/Edit nci

`5. What was your opinion of this class over the semester.
    a. outstanding b. very good c. average d. poor
    e. terrible

7. What do you think your semester grade should be?
   a. A  b. B  c. C  d. D
   e. F

When you are done with this test give it to the Instructor, have a nice semester break, I hope to see you next semester.

**San Diego City College**
1313 Twelfth Ave.
San Diego, Ca. 92101

## Machine Technology 170 Final Examination

### NO BOOKS OR NOTES

### DO NOT WRITE ON THIS TEST. WRITE ONLY ON THE SCANTRON SHEET.

This test is being given to see what you know. Do not look at anyone else's paper or ask anyone questions. If you have any questions ask the instructor. Raise your hand to get his attention.

If the instructor sees anyone looking at someone else's paper, or talking during the test, he/she will have their paper taken and receive a "0" grade for the test.

The pretest grade has no impact on your final grade it simply allows us to measure information learned by the student.

1. To start the Fadal in is important to check the:
   a. Air pressure
   b. Oil level
   c. Hydraulic fluid
   d. a & c
   e. b & a

2. If the Fadal's air pressure is below__ don't use it.
   a. 60 P.S.I.
   b. 70 P.S.I.
   c. 80 P.S.I.
   d. 90 P.S.I.
   e. 100 P.S.I.

3. You must align the axes: X,Y,&Z using the___ ?
   a. Alignment marks
   b. Indicator lights
   c. Block delete switch
   d. M.D.I. mode
   e. Command mode

4. The axes must be aligned within ____.
   a. 1/16 of an inch
   b. 3/32 of an inch
   c. 1/8 of an inch
   d. 1/64 of an inch
   e. none of the above

5. If the axes: X,Y,&Z are not properly aligned we use the ___ mode to move them into location.
   a. Command Mode
   b. M.D.I. Mode
   c. Jog Mode
   d. Auto mode
   e. Single Step

6. When the axes: X,Y,&Z are properly aligned we set the mode to?
   a. Jog Mode
   b. M.D.I. Mode
   c. Command Mode
   d. tool change
   e. Single Step

7. When the axes: X,Y,&Z are properly aligned we use the ___ command.
   a. set cs
   b. set x
   c. set y
   d. cs
   e. none of the above.

8. To insert tools in the spindle we use the?
   a. Spindle on /off button
   b. Tool in/out button
   c. Tool exchange button
   d. Manual button
   e. Slide hold

9. To change tools we use the?
   a. Command Mode
   b. M.D.I. Mode
   c. Jog Mode
   d. Auto mode
   e. Single Step

10. When entering the tool length offset we must be in the.
   a. Jog Mode
   b. M.D.I. Mode
   c. Command Mode
   d. Auto mode
   e. Single Step

11. A time saving tip to set the tool length for tool number 1 and modifying it for a 1" gauge block is.
   a. sl,1.-1.0
   b. sl,1,+1.0
   c. sl,1,+-1.0
   d. sl,1 enter, then sl,1,-1.0

12. To set the machine x&y zero an edge finder works well?
   a. True
   b. False

13. To set the part x&y zero we enter the command.
   a. set x
   b. set y
   c. set cs
   d. ho
   e. a & b

14. To display the tool length offsets we enter?
    a. pr
    b. ta,1
    c. cs
    d. ho
    e. dt

15. To remove a program from the Fadal we enter?
    a. pr
    b. ta,1
    c. cs
    d. ne
    e. dt

16. To edit a program in the Fadal we enter?
    a. pr
    b. ta,1
    c. cs
    d. pa
    e. dt

17. To load a program completely into the Fadal's controler we enter __on the first line of the program.
    a. pr
    b. ta,1
    c. dnc
    d. pa
    e. dt

18. To load a program that doesn't fit completely into the Fadal's controller we enter __on the first line of the program.
    a. pr
    b. dnc,1,9
    c. dnc
    d. pa
    e. ta,1

19. To switch from one program to another at the Fadal we would start by entering?
    a. pr
    b. setcs
    c. dnc
    d. pa
    e. ta,1

20. To view a program in the Fadal without having the ability to edit it we can use the ___ command.
    a. pst
    b. list
    c. dnc
    d. cs
    e. ta,1

21. To run a program in the Fadal we can use the ___ command.
    a. hold
    b. list
    c. dnc
    d. sum
    e. au

22. When shutting down the Fadal we enter the ___ commands to return the machine to the machine zero positions.
    a. setcs
    b. setcs,ho
    c. ho
    d. cs,ho
    e. au,sl

23. To modify a Tool diameter offset we would use ?
    a. setcs
    b. setcs,ho
    c. ho
    d. cs,ho
    e. dt

24. If we wanted the machine to stop at the end of each line of program we would be in the.
    a. Command Mode
    b. M.D.I. Mode
    c. Jog Mode
    d. Auto mode
    e. Single Step

25. To enter Fixture Offset number 1 into the controller we would type in.
    a. Fix,1
    b. Ta,1
    c. Fo,1
    d. DNC,1

26. To call out a Fixture offset in a C.N.C. program we use the command.
    a. Fix,1
    b. Ta,1
    c. Fo,1
    d. E1

27. If we saw the command G41D1 in a C.N.C. program we would know to check the .
    a. Cutter diameter in offset number 41
    b. Cutter diameter in offset number G41D
    c. Cutter diameter in offset number 1
    d. Cutter diameter in offset number sl,1

Commonly used "G" & "M" CODES & MISCELLANEOUS CODES

28. G91:
    a. HEIGHT (TOOL LENGTH OFFSET)
    b. X,Y PLANE SELECTION
    c. SET X,Y,Z, VALUES, RESET VALUES
    d. INCREMENTAL PROGRAMMING
    e. DRILL WITH DWELL AT END OF "Z" TRAVEL
29. M06:
    a. SPINDLE ON CLOCKWISE
    b. SPINDLE ON COUNTER CLOCK
    c. MACHINE STOP, STOPS EVERYTHING
    d. RETRACT SPINDLE TO HOME POSITION
    e. KILLS CANNED CYCLES
30. G02:
    a. COUNTER CLOCKWISE ARC REQUIRES AXIS MODIFIERS
    b. STRAIGHT LINE MOVE REQUIRES FEED RATE
    c. SET X,Y,Z, VALUES, RESET VALUES
    d. CUTTER COMPENSATION LEFT
    e. CLOCKWISE ARC REQUIRES AXIS MODIFIERS
31. "S":
    a. FAST RAPID POSITIONING MOVE
    b. STRAIGHT LINE MOVE REQUIRES FEED RATE
    c. X AXIS MODIFIER
    d. SPINDLE STOP
    e. SPEED
2. M00:
    a. KILL COOLANT
    b. SET X,Y,Z, VALUES, RESET VALUES
    c. OPTIONAL STOP, ACTS AS M00 OR DISAPPEARS
    d. MACHINE STOP, STOPS EVERYTHING
    e. SPINDLE STOP
33. G00:
    a. FAST RAPID POSITIONING MOVE
    b. BORE IN AND OUT
    c. MACHINE STOP, STOPS EVERYTHING
    d. CUTTER COMPENSATION LEFT
    e. CANCELS CUTTER COMPENSATION
34. "I":
    a. INCREMENTAL PROGRAMMING
    b. Z AXIS MODIFIER
    c. X AXIS MODIFIER
    d. MIST COOLANT
    e. Y,Z PLANE SELECTION
35. M01:
    a. INCREMENTAL PROGRAMMING
    b. OPTIONAL STOP, ACTS AS M00 OR DISAPPEARS
    c. END OF PROGRAM, STOP
    d. MIST COOLANT
    e. CUTTER COMPENSATION RIGHT
36. M08:
    a. SPINDLE ON CLOCKWISE
    d. MIST COOLANT

c. PECK CYCLE, DEEP HOLE DRILLING
d. FLOOD COOLANT
e. CLOCKWISE ARC REQUIRES AXIS MODIFIERS

37. G03:
a. STRAIGHT LINE MOVE REQUIRES FEED RATE
b. COMMON DRILL CYCLE
c. CLOCKWISE ARC REQUIRES AXIS MODIFIERS
d. CUTTER COMPENSATION RIGHT
e. COUNTER CLOCKWISE ARC REQUIRES AXIS MODIFIERS

38. M04:
a. SPINDLE ON CLOCKWISE
b. DWELL
c. MACHINE STOP, STOPS EVERYTHING
d. SPINDLE ON COUNTER CLOCKWISE
e. SPINDLE STOP

39. M09:
a. COUNTER CLOCKWISE ARC REQUIRES AXIS MODIFIERS
b. SPINDLE ON COUNTER CLOCK
c. KILL COOLANT
d. KILLS CUTTER COMPENSATION
e. KILLS CANNED CYCLES

40. "F":
a. FAST RAPID POSITIONING MOVE
b. FEED
c. COMMON DRILL CYCLE
d. FLOOD COOLANT
e. OFFSET NUMBER (TOOL DIAMETER)

41. M02:
a. SPINDLE ON CLOCKWISE
b. SPINDLE ON COUNTER CLOCKWISE
c. END OF PROGRAM, STOP
d. END OF PROGRAM, RETURN TO BEGINNING OF PROGRAM AND WAIT
e. CUTTER COMPENSATION RIGHT

42. "H":
a. HEIGHT (TOOL LENGTH OFFSET)
b. FEED
c. Y AXIS MODIFIER
d. RETRACT SPINDLE TO HOME POSITION
e. SPEED

43. G01:
a. FAST RAPID POSITIONING MOVE
b. STRAIGHT LINE MOVE REQUIRES FEED RATE
c. SET X,Y,Z, VALUES, RESET VALUES
d. REAMING CYCLE, STOPS SPINDLE AT "Z" DEPTH
e. X,Z AXIS MOVEMENT

44. G17:
a. X,Y AXIS MOVEMENT
b. X,Y PLANE SELECTION
c. X,Z PLANE SELECTION
d. X,Z AXIS MOVEMENT
e. Y,Z PLANE SELECTION

45. "J":
   a. HEIGHT (TOOL LENGTH OFFSET)
   b. Z AXIS MODIFIER
   c. Y AXIS MODIFIER
   b. Z AXIS MODIFIER
   e. Y,Z PLANE SELECTION

46. MO3:
   a. SPINDLE ON CLOCKWISE
   b. DWELL
   c. END OF PROGRAM, STOP
   d. SPINDLE STOP
   e. CLOCKWISE ARC REQUIRES AXIS MODIFIERS

47. G90:
   a. INCREMENTAL PROGRAMMING
   b. METRIC PROGRAMMING
   c. X,Z, PLANE SELECTION
   d. ABSOLUTE PROGRAMMING
   e. CANCELS CUTTER COMPENSATION

48. "T":
   a. HEIGHT (TOOL LENGTH OFFSET)
   b. FEED
   c. END OF PROGRAM, STOP
   d. MIST COOLANT
   e. COMMONLY STANDS FOR TOOL

49. G18:
   a. X,Y,AXIS MOVEMENT
   b. X,Y PLANE SELECTION
   c. Y,Z PLANE SELECTION
   d. Y,Z AXIS MOVEMENT
   e. X,Z PLANE SELECTION

50. "K":
   a. X AXIS MODIFIER
   b. Z AXIS MODIFIER
   c. Y AXIS MODIFIER
   d. X,Z, PLANE SELECTION
   e. Y,Z PLANE SELECTION

51,52,53.
To obtain a better surface finish it is better to decrease the _#51_,rather then _#52_ the _#53_.
   a. Speed  b. feed  c. depth of cut  d. increase
   e. none of these

54. The biggest difference between NC and computer numerical control (CNC) is the addition of the on board ?
.
   a. MDI
   b. digital read out display
   c. automatic tool change "Z" heights
   d. computer
   e. none of these

Question 55, 56, and 57

Name three advantages of CNC:

55. a. low maintenance
    b. not cost effective for low production levels
    c. increased productivity
    d. higher operator skills required
    e. Jack said so

56. a. lower flexibility
    b. greater flexibility
    c. good chip removal
    d. special purpose applications
    e. none of these

57. a. reduced production costs
    b. high production costs
    c. low accuracy and repeatability
    d. none of the above
    e. none of these

Name three limitations of CNC: questions58,59,60

58. a. machinery is too heavy
    b. need too many manuals to interpolate codes
    c. on board computer is too small
    d. not cost effective for low production levels
    e. none of these

59. a. requires highly trained operators
    b. high maintenance requirement
    c. low flexibility
    d. insufficient data input at the MDI
    e. none of these

60. a. low initial cost
    b. high production of repeatability parts
    c. facilitation of inflexible automation
    d. high initial investment
    e. none of these

61. What is the name of the system that will not correct itself from path deviation when moving from one point to another?
    a. closed-loop system
    b. interpolation
    c. proportional gain
    d. open-loop system
    e. none of these

62. What is the name of the system that **will** correct itself from path deviation when moving from one point to another?
    a. open-loop system
    b. integral gain
    c. closed-loop system
    d. interpolation
    e. none of these

63.&64.
In the #63 ,positioning system, all points are measured from a fixed point or origin, and it's "G" code is #64 .

| | |
|---|---|
| a. absolute | a. G91 |
| b. incremental | b. G92 |
| c. fast rapid position move | c. G90 |
| d. set X,Y,Z values, reset values. | d. G00 |

65. &66
In the#65 , positioning system, the reference point from which the dimensions are measured is not fixed. Instead, it moves to the immediate preceding point from operation to operation. It's "G" code is #66 .

| | |
|---|---|
| a. absolute | a. G91 |
| b. incremental | b. G92 |
| c. fast rapid position move | c. G90 |
| d. set X,Y,Z values, reset values. | d. G00 |

67. What is the formula for calculating spindle speeds for CNC machining in Revolutions Per Minute?
    a. RPM= Pi X D divided by CS X 12
    b. RPM= CS X 12 divided by Pi X D
    c. RPM= CS X 4 divided by D
    d. none, automatically set with MDI on the CNC machine

68. What is the formula for calculating feeds for CNC machining in Inches Per Minute?
    a. IPM= Pi X D divided by CS X 12
    b. IPM= number of teeth on cutter X chip load per tooth
    c. none, geometry set with MDI on the CNC machine
    d. IPM= RPM X number of teeth on cutter X chip load per tooth

69. How many tools can we load into our Fadal.
    a. 15
    b. 19
    c. 20
    d. 21
    e. 22

70. How fast does the Fadal move when it reads a G00 command.
    a. 150 IPM
    b. 200 IPM
    c. 300 IPM
    d. 350 IPM
    e. 400 IPM

71. How much travel do we have in the X axis
    a. 20 "
    b. 30"
    c. 35"
    d. 40"
    e. 45"

72. How much travel do we have in the Y axis
    a. 20 "
    b. 30"
    c. 35"
    d. 40"
    e. 45"

73. What is the fastest rate that the Fadal can travel using the G01 command.
    a. 150 IPM
    b. 200 IPM
    c. 300 IPM
    d. 350 IPM
    e. 400 IPM

74. How many R.P.M.s do we have with our Fadal
    a. 6000
    b. 7000
    c. 8000
    d. 9000
    e. 10000

75. How many horsepower do we have with our Fadal
    a. 17 b. 19 c. 22
    d. 23 e. 24

76. The G08 command tells the Fadal to decelerate at every end point.
    a. True b. False

77. The G09 command tells the Fadal to decelerate at every end point.
    a. True b. False

78. We can write programs at the Fadal controller.
    a. True b. False

79. CD,8 removes the active program from memory in the Fadal.
    a. True b. False

80. TA,1 changes tool length offsets.
    a. True b. False

81. If you saw the G75 command in a Fadal program you would know that this is a _____Cycle
    a. Drilling b. Reaming c. Counterbore
    d. Tapping

82. Our Fadal uses the _____ Command for tapping, because of the tapping head we have.
    a. G71 b. G83 c. G75
    d. G85

83. In the G75 command the Q desiginates the_____ .
a. Standard of thread b. Diameter of thread c. R.P.M.
d. Pitch of thread

84. The _____ Command activates the engraving cycle
a. L9701 b. L9601 c. L9801
d. L93NN e. L9201

85. The _____ Command activates the Bolt Circle
a. L9701 b. L9601 c. L9801
d. L93NN e. L9201

86. The _____ Command activates the rectangular pocket cycle in a counter clock wise rotation
a. L9701 b. L9601 c. L9801
d. L93NN e. L9201

87. The _____ Command activates the circular pocket cycle in a counter clock wise rotation
a. L9701 b. L9601 c. L9801
d. L93NN e. L9201

88. We would use the command _____ To input a fixture offset command.
a. E1 b. FO c. CSd. SLe. TA

89. We would use the command _____ To retrieve and activate a fixture offset command.
a. E1 b. FO c. CSd. SLe. TA

90. The code_____ Is used to separate suroutines
a. G17 b. M1 c. M30
d. M17 e. M00

91. The code_____ Is used at the end of all subroutines
a. G17 b. M1 c. M30
d. M17 e. M00

92. If I wanted to name a subroutine as number 1 subroutine I would use the_____ Command.
a. L0001 b. E01 c. L10001
d. L0101 e. L0100

93. If I wanted to execute the subroutine named number two, and run it 12 times the command would be
a. L12 b. L0212 c. E212d. F0212

94. If we are using the DNC method of communication we can edit the code that is on the floppy disk
a. True b. False

95. The letter for the axis that rotates around the X axis is
a. A b. B c. C
d. D

96. If I saw the command G17 Q2.365 I would know we are
a. A axis mapping b. B axis mapping c. C axis mapping
d. None of these

97. To turn on the mirror image we would use the
a. G50.1 b. G51.1 c. G50 d. G51

98. The reaming cycle used on the FADAL is
a. G83 b. G81 c. G70
d. G86

99. The letter R is often used in canned cycles on the FADAL it always represents the same thing
a. True b. False

100. What do you think your grade should be for this class this semester.
a. A b. B c. C
d. D e. F

When you are done with this test give it to the Instructor

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San Diego, Ca. 92101

**Machine Technology 180 Final Examination**

**NO BOOKS OR NOTES**

**DO NOT WRITE ON THIS TEST. WRITE ONLY ON THE SCANTRON SHEET.**

This test is being given to see what you know. Do not look at anyone else's paper or ask anyone questions. If you have any questions ask the instructor. Raise your hand to get his attention.

If the instructor sees anyone looking at someone else's paper, or talking during the test, he/she will have their paper taken and receive a "0" grade for the test.

The pretest grade has no impact on your final grade it simply allows us to measure information learned by the student.

1. Which conversion process converts XY and XYZ coordinates into points, lines and splines
   a. CADL b. DXF c. ASCII d. IGES

2. Which conversion process was originated by Autodesk for its AutoCad product, splines are not supported in this product
   a. CADL b. DXF c. ASCII d. IGES

3. Which conversion process was originated by Cadkey product
   a. CADL b. DXF c. ASCII d. IGES

4. Which conversion process is the US standard, and normally the best choice
   a. CADL b. DXF c. ASCII d. IGES

. Using conversion files we can normally use a file created in one package, in another
   a. True b. False

6. A wire frame model is normally used to create surface models
   a. True b. False

7. A surface can be thought of as the "Skin" that is stretched across a wire frame
   a. True b. False

8. MasterCam has two types of Geometric Surfaces one example is
   a. Loft b. Draft c. Ruled d. Coons

9. MasterCam has two types of Geometric Surfaces one example is
   a. Blend b. Flow c. Revolution d. Fillet

10. Surfaces can be rendered:
    a. True b. False

11. Wire frame models can be rendered in MasterCam
    a. True b. False

12. Draft surfaces are an example of_____ Surfaces
    a. Geometrical b. Free- form c. Derived d. Modified

13. Revolved surfaces are an example of_____ Surfaces
    a. Geometrical b. Free- form c. Derived d. Modified

14. Ruled surfaces are an example of_____ Surfaces
    a. Geometrical b. Free- form c. Derived d. Modified

15. Lofted surfaces are an example of_____ Surfaces
a. Geometrical b. Free- form c. Derived d. Modified

16. 2-D swept surfaces are an example of_____ Surfaces
a. Geometrical b. Free- form c. Derived d. Modified

17. 3-D swept surfaces are an example of_____ Surfaces
a. Geometrical b. Free- form c. Derived d. Modified

18. Coons surfaces are an example of_____ Surfaces
a. Geometrical b. Free- form c. Derived d. Modified

19. Offset surfaces are an example of_____ Surfaces
a. Geometrical b. Free- form c. Derived d. Modified

20. Trimmed surfaces are an example of_____ Surfaces
a. Geometrical b. Free- form c. Derived d. Modified

21. Fillet surfaces are an example of_____ Surfaces
a. Geometrical b. Free- form c. Derived d. Modified

22. Blend surfaces are an example of_____ Surfaces
a. Geometrical b. Free- form c. Derived d. Modified

23. When creating a Fillet surface it is very important that the surface normals both point toward the
a. Top view b. center of the arc c. 3 -D construction view d. Common data point

24. This surface is formed by linearly blending at least 2 contours
a. Revolution b. Swept c. Coons d. Lofte. Ruled

25. This surface is formed by blending parabolically more then 2 contours
a. Revolution b. Swept c. Coons d. Lofte. Ruled

26. This surface is formed by blending a grid of closed boundaries
a. Revolution b. Swept c. Coons d. Lofte. Ruled

27. This surface is formed by driving one or two contours along one or two rails
a. Revolution b. Swept c. Coons d. Lofte. Ruled

28. This surface is formed by rotating a contour about an axis or line of rotation
a. Revolution b. Swept c. Coons d. Lofte. Ruled

29. A surface model that is formed from many surfaces is called a _____ Surface
a. Conglomerate b. Flowline c. Composite d. Coons

30. A lofted surface and a ruled surface always will give us the same result
a. True b. False

31. Mastercam provides three forms of surface mathematics on example is
a. Nurbs b. Loft c. Swept d. Coonse. Loft

32. Mastercam provides three forms of surface mathematics on example is
a. Ruled b. Loft c. Swept d. Parametrice. Loft

33. Mastercam provides three forms of surface mathematics on example is
a. Blend b. Loft c. Swept d. Coonse. Loft

34. In blending Coons surfaces this method is normally used in a single patch surface
a. Cubic with slope blending b. Parabolic c. Lineard. Cubic

35. In blending Coons surfaces this method is normally used in multiple patch surfaces when ever possible, the flat spots are eliminated
a. Cubic with slope blending b. Parabolic c. Lineard. Cubic

36 In blending Coons surfaces this method is normally used in multiple patch surfaces, these surfaces tend to produce flat spots
a. Cubic with slope blending b. Parabolic nurbs c. Lineard. Cubic

37. The 3-d toolpath module allows us to Machine advanced parts even if we don't have surfacing capabilities
a. True b. False

38. To switch between open windows applications you would use the____,____ Keys from this selection.
a. Cntrl/Alt b. Tab/Cntrl c. Alt/Tab d. Tab/esc

39. What Windows application takes the place of most D.O.S. commands?
a. Write b. Paint c. File manager d. Program Manager

40. Using Windows you can have ***more*** then one application open at a time?
a. True b. False

41. You can see "list" all the open applications you have in Windows using the____/____Keys from this selection.
a. Cntrl/Alt/Del b. Tab/Cntrl c. Alt/Tab d. Cntrl/Esc

42. To send a graphic image to the Clipboard so we can print it from the Paint program we would use the _____. Keys from this selection.
a. Alt/Del b. Cntrl/Print Screen c. Alt/Tab d. Cntrl/Alt

43. In Windows we can quickly close an application using the_____ keys.
a. Alt/Del b. Alt/F4 c. Alt/Tab d. Cntrl/Alt

44. If I wanted to zoom a window in mastercam using the function keys I would use____.
a. F1
b. F7
c. F5
d. F10
e. Alt F1

45. If I wanted to automatically fit a design in mastercam using the function keys I would use____.
a. F1
b. F7
c. F5
d. F10
e. Alt F1

46. If I wanted to delete an entity in mastercam using the function keys I would use____.
a. F1
b. F7
c. F5
d. F10
e. Alt F1



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47. If I wanted to modify an entity in mastercam using the function keys I would use____.
    a. F1
    b. F7
    c. F5
    d. F10
    e. Alt F1

48. If I wanted to repaint the design in mastercam using the function keys I would use___.
    a. F1
    b. F2
    c. F3
    d. F4
    e. F5

49. If I wasn't sure of a function key in mastercam I would use the___function key.
    a. F1
    b. F3
    c. F5
    d. F10
    e. Alt F1

The following questions are associated with Figure-1, do not duplicate answers.

50. In MasterCam If I wanted to create a surface file for the #1 drawing I would most likely choose?

    a. Loft
    b. Ruled
    c. Contour
    d. Pocket
    e. Coons

51. In MasterCam If I wanted to create a surface file for the #2 drawing I would most likely choose?

    a. Loft
    b. Ruled
    c. 3D Swept
    d. 2D Swept
    e. Coons

52. In MasterCam If I wanted to create a surface file for the #3 drawing I would most likely choose?

    a. Loft
    b. Ruled
    c. 3D Swept
    d. 2D Swept
    e. Coons

53. In MasterCam If I wanted to remove the all the material inside the boundary for drawing # 4,I would most likely choose?

    a. Loft
    b. Ruled
    c. 3D Swept
    d. Contour
    e. Pocket

54. In MasterCam If I wanted to machine around the outside boundary of drawing #5,I would most likely choose?

a. Loft
b. Ruled
c. 3D Swept
d. Contour
e. Pocket

55. In MasterCam If I wanted to create a surface file for the #6 drawing I would most likely choose?

a. Loft
b. Ruled
c. 3D Swept
d. 2D Swept
e. Revolution

56. In MasterCam If I wanted to create a surface file for the #7 drawing I would most likely choose?

a. Loft
b. Ruled
c. 3D Swept
d. 2D Swept
e. Revolution

57. In MasterCam If I wanted to create a surface file for the #8 drawing I would most likely choose?

a. Pocket
b. Ruled
c. 3D Swept
d. 2D Swept
e. Revolution

58. A rule of thumb for the depth of cut would be.
a. full depth of cut of the flute length
b. three quarter depth of cut of the cutter diameter
c. one fourth to one half depth of cut of the cutter diameter
d. not relative to the flute length or cutter diameter
e. one eight depth of cut of the flute length

59. What factor if increased 50%, would have the #1 bad effect on the cutter life.
a. depth of cut
b. feed
c. RPM
d. surface feed per minute
e. length of cutter flute

60. What factor if increased 50%, would have the #2 bad effect on the cutter life.
a. RPM
b. surface feed per minute
c. depth of cut
d. feed
e. length of cutter flute

61. What factor if increased 50%, would have the least bad effect on the cutter life.
a. RPM
b. feed
c. depth of cut
d. surface feed per minute
e. length of cutter flute

62. What is the formula for calculating spindle speeds for CNC machining in Revolutions Per Minute?
    a. RPM= Pi X D divided by CS X 12
    b. RPM= CS X 12 divided by Pi X D
    c. RPM= CS X 4 divided by D
    d. none, automatically set with MDI on the CNC machine

63. What is the formula for calculating feeds for CNC machining in Inches Per Minute?
    a. IPM= Pi X D divided by CS X 12
    b. IPM= number of teeth on cutter X chip load per tooth
    c. none, geometry set with MDI on the CNC machine
    d. IPM= RPM X number of teeth on cutter X chip load per tooth

64. To copy a file named: 2DEX1.TXT from A:\ to C:\ZIP> you would type___from the A:\> prompt.
    a. COPY 2DEX1.TXT C:\ZIP
    b. COPY2DEX1.TXTC:\ZIP
    c. 2DEX1.TXT COPY C:\ZIP
    d. COPY *.*2DEX1.TXT C:\ZIP

65. To change from C:\bat> to C:\zip> you would type:
    a. Cd./zip/ b. Cd Zip c. Cd/zip d. cd bate: cd\zip

66. To erase all the files ending with the extension "TXT" you would type___at the A:\> prompt.
    a. ERASE *.*TXT
    b. REMOVE TXT.*
    c. DEL *.*TXT
    d. DEL *.TXT
    e. none of the above

67. To make a sub-directory named "ZIP" on drive A:\> you would type___at the A:\> prompt.
    a. ZIP b. MD "ZIP c. MD ZIP d. none of these

68. If the directory B:\ZIP> was empty and you wanted to remove it you would type___at the B:\> prompt.
    a. DEL B:\ZIP b. REN B:\ZIP c. ERASE B:\ZIP d. RD ZIP

69. What would you type from the C:\ZIP> prompt to format a floppy disk in drive "A".
    a. A:\FORMAT
    b. FORMAT
    c. C:\ FORMAT\A:\
    d. FORMAT A:
    e. NONE OF THE ABOVE

## MASTERCAM

70. What are the reason(s) to use the hard drive for Mastercam?
    a. it is the only drive that Mastercam will recognize
    b. the floppy disks will only work when formatted by mastercam
    c. more available space and faster response time
    d. slower response time and more available space

71. Mastercam is___?
    a. a stand alone program use exclusively at City College
    b. a scientific graphics program
    c. a fully integrated CAD/CAM program
    d. none of the above

72. Mastercam creates___?
    a. drawings
    b. geometry
    c. only single entity wire frame outlines
    d. mathematical equations only

73. The file extension for a mastercam graphics file is:___.
    a. .nc
    b. .nci
    c. .dfx
    d. .ge3
    e. .tp

74. The file extension for a mastercam CNC program is:___.
    a. .nc
    b. .nci
    c. .dxf
    d. .ge3
    e. .tp

Question 75, 76, 77, 78

As soon as we choose the **toolpath** menu we crossed over from the __#75__ section into the __#76__ section of mastercam. The extension for this file is __#77__, this stands for __#78__. Answer selection to the above questions.

75. a. graphics
    b. ruled
    c. swept
    d. CAD
    e. CAM

76. a. toolpath
    b. swept
    c. graphics
    d. CAD
    e. CAM

77. a. .nci
    b. .nc
    c. .doc
    d. .mac
    e. .tp

78. a. numerical control intermediate
    b. numerical control
    c. document file
    d. mastercam file
    e. tool path

79. Which mastercam menu is used to "DRAW" geometry?
    a. create  b. file  c. drafting  d. line
    e. nc edit

80. Which mastercam menu selection is used to save or get geometry:
    a. save  b. next menu  c. nc utiiities  d. file

Question 81 and 82

If I was cutting along the outside of project 2dex1 this would be considered a __#81__, which cutter compensation would I use to climb mill __#82__?

Answer selection to the above questions.

81. a. pocket
    b. drill
    c. swept
    d. contour
    e. ruled

82. a. cutter compensation off
    b. cutter compensation left
    c. cutter compensation right
    d. deflect cutter compensation
    e. cutter compensation center

Question 83 and 84

If I was cutting out the inside of project 2dex1 this would be considered a #83 , which cutter compensation ould I use to climb mill #84 ?

Answer selection to the above questions.

83. a. pocket
    b. drill
    c. swept
    d. contour
    e. ruled

84. a. cutter compensation off
    b. cutter compensation left
    c. cutter compensation right
    d. deflect cutter compensation
    e. cutter compensation center

85. Name 1 way of drawing an arc in mastercam? (from the main menu)
    a. create, arc, radius
    b. create, arc, vertical
    c. create, arc, endpoints
    d. arc, horizontal, values

86. Name 1 way of drawing an point in mastercam? (from the main menu)
    a. create, point, endpoints, sketch
    b. create, point, position, values
    c. create, point, center, values
    d. create, point, intersection, midpoint

87. To make a print out of the design created in mastercam I would choose, #87 , _____ , _____ .
    a. file, exit, A:\print
    b. file, create, print
    c. create, print, hard copy
    d. file, hard copy
    e. create, print, design

uestion 88,89,90

What is the operation used in mastercam that is a form of verification #88 . This is a limited process since it only shows the center line of the #89 . It also shows the #90 it estimated to machine the part.

Answer selection to the above questions.

88. a. NSEE
    b. Vericut
    c. plot
    d. backplot
    e. edit nci

89. a. toolpath
    b. visual aid
    c. tool change
    d. cutter number
    e. section lines

90. a. space
    b. cuts
    c. section area
    d. fixture
    e. time

91. If I wanted to add a new toolpath to an existing toolpath I would use the #91 choice, in the toolpath section.
    a. write over
    b. delete
    c. auto delete
    d. append
    e. all of the above

92. If I wanted to remove a section of toolpath from an existing file I would use _____ / _____ . (from the main menu)
    a. file, get
    b. file, delete
    c. nc utilities, plot
    d. nc utilities, geometry
    e. nc utilities, edit nci

93. If I wanted to change a "toolpath" into a CNC program I would have to_____.
    a. backplot/plot
    b. convert to a .tp file
    c. post process
    d. edit nc
    e. none of the above

94. If I wanted to make some changes in the CNC program I would have to use the___ selection.
    a. .ge3 file
    b. .tp file
    c. edit
    d. vericut program
    e. nsee program

95. To activate the editor in mastercam I would have to choose____/_____/_____. (from the main menu)
    a. directory, file, edit
    b. file, post process, edit
    c. create, nc utilities, change
    d. file, edit, nc
    e. none of the above

96. In the editor, if I decide not to keep the changes I made, I would select __/__.
    a. File, Close
    b. File, Save as
    c. File, Save
    d. File, Mistake
    e. none of the above

97. In the editor, if I decide to keep the changes I made, With the same name I would select__/__.
    a. File, Close
    b. File, Save as
    c. File, Open
    d. File, Save
    e. none of the above

98. In the editor, if I wanted to keep the changes to the program I made, but give it a different name I would enter___/____.
    a. File, Close
    b. File, Save as
    c. File, Open
    d. File, Save
    e. none of the above

99. In MasterCam If I wanted to document the tools I am using for a project I could have the computer check the *.nci file and create a ___ this could be given to the operator, or used later.
    a. C.N.C. program  b. Tool file  c. Material document
    d. Geometry file
    e. set up sheet

100. What grade do you think you deserve in this class this semester
    a. A  b. B  c. C  d. De. F

When you are done with this test give it and your answer sheet to the instructor.

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